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ABBREVIATED TITLES USED IN THE ABSTRACTS

Abbreviated Title.	*Journal.*
Aircr. Engng	Aircraft Engineering.
Ann. Min. Belg.	Annales des Mines de Belgique.
Ann. Min. Roumanie	Annales des Mines de Roumanie.
Ann. Off. Combust. liq.	Annales de l'Office National des Combustibles Liquides.
Asph. u. Teer	Asphalt und Teer.
Auto. Engr	Automobile Engineer.
Auto. Tech. Z. (*Berlin*)	Automobiltechnische Zeitschrift (Berlin).
Azerb. neft. Khoz.	Azerbaidzhanskoe Neftyanoe Khozyaistvo.
Beitr. angew. Geophys.	Beitrage angewandte Geophysik.
Beitr. Geophys.	Beitrage zur Geophysik.
Bitumen	Bitumen.
Bohrtech. Z.	Bohrtechniker Zeitung.
Bol. Geol. y Min. (*Caracas*)	Boletin de Geologia y Mineria (Caracas).
Bol. Inform. Petroleras (*B.A.*)	Boletin de Informaciones Petroleras (Buenos Aires).
Boll. Soc. geol. ital.	Bolletin de la Societa Geologica Italiana.
Brennst Chemie	Brennstoff Chemie.
Bull. Acad. Sci. (*U.S.S.R. Inst. Seismol.*)	Bulletin of the Academy of Sciences (U.S.S.R. Institute of Seismology).
Bull. Amer. Ass. Petrol. Geol.	Bulletin of the American Association of Petroleum Geologists.
Bull. Amer. geol. Soc.	Bulletin of the American Geological Society.
Bull. Ass. franç. Tech. Pétrol.	Bulletin de l'Association Français des Techniciens du Pétrole.
Bull. Inst. Min. (*metall.*) *Engrs*	Bulletin of the American Institute of Mining and Metallurgical Engineers.
Bull. Math. Phys. Éc. polyt. Bucharest	Bulletin de Mathematique et de Physique, Bucharest (École-polytechnique).
Bull. roum. geol. Soc.	Bulletin of the Roumanian Geological Society.
Bull. seismol. Soc. Amer.	Bulletin of the Seismological Society of America.
Bull. Univ. Texas (*Bur. econ. Geol. Techn.*)	Bulletin of the University of Texas (Bureau of Economic Geology and Technology).
Bur. Stand. J. Res., Wash.	United States Bureau of Standards Journal of Research, Washington.
Calif. Oil World	California Oil World.
Canad. J. Res.	Canadian Journal of Research.
Canad. Min. J.	Canadian Mining Journal.
Canad. Min. metall. Bull.	Bulletin of the Canadian Institute of Mining and Metallurgy.
Chem. & Ind.	Chemistry and Industry.
Chem. Rev.	Chemical Reviews.
Chem. Tr. J.	Chemical Trade Journal.
Chem. Wkbld	Chemische Weekblad.
Chim. e Industria	La Chimica e l'Industria.
Chim. et Ind.	Chimie et Industrie.
C.R. Acad. Sci. (*Paris*)	Comptes Rendus hebdomadaires des Seances de l'Academie des Sciences (Paris).
C.R. Geol. Pétr. (*Strasbourg*)	Compte-Rendu des Seances du Groupe des Geologues Pétroliers de Strasbourg.
II^me Congrès Mond. Pétrole	II^me Congrès Mondial du Pétrole (Paris, 1937).
Diesel Eng. Us. Ass.	Diesel Engine Users Association.
Direccion Minas y Geol.	Publication of Direccion Minas y Geologicas (Argentine).
Econ. Geol.	Economic Geology.
Engineer	Engineer.
Engineering	Engineering.
E.P.	English Patent.
Fuel	Fuel in Science and Practice.
Gas Oil Pwr	Gas and Oil Power.
Geol. Mag. (*Lond.*)	Geological Magazine (London).
Geophys.	Geophysics.

Abbreviated Title.	*Journal.*
Glückauf	Glückauf.
Groz. Neft.	Groznenskii Neftyanik.
Industr. Engng Chem.	Industrial and Engineering Chemistry.
Industr. Engng Chem. Anal.	Industrial and Engineering Chemistry, Analytical Edition.
Industr. Pwr & Fuel Econ.	Industrial Power and The Fuel Economist.
Instruments	Instruments.
Int. Z. Bohrtech.	International Zeitschrift für Bohrtechnik.
J. Amer. chem. Soc.	Journal of the American Chemical Society.
J. appl. Chem. (U.S.S.R.)	Journal of Applied Chemistry, U.S.S.R.
J. appl. Phys.	Journal of Applied Physics.
J. chem., metall. min. Soc. S. Africa	Journal of the Chemical, Metallurgical and Mining Society of South Africa.
J. chem. Soc.	Journal of the Chemical Society.
J. Fuel Soc. Japan	Journal of the Fuel Society of Japan.
J. Geol.	Journal of Geology.
J. Inst. Fuel	Journal of the Institute of Fuel.
J. Instn auto. Engrs	Journal of the Institution of Automobile Engineers.
J. Inst. Petrol.	Journal of the Institute of Petroleum.
J. org. Chem.	Journal of Organic Chemistry.
J. phys. Chem.	Journal of Physical Chemistry.
J. R. aero. Soc.	Journal of the Royal Aeronautical Society.
J. Soc. aut. Engrs	Journal of the Society of Automotive Engineers.
J. Soc. chem. Ind.	Journal of the Society of Chemical Industry.
Khim. Tverd. Topliva	Khimiya Tverdovo Topliva.
Kop. Naft. Polsce	Kopalnictwo Naftowe w Polsce.
Matières grasses	Matières Grasses.
Min. & Metall.	Mining and Metallurgy.
Min. Mag. (Lond.)	Mining Magazine (London).
Monit. Pétr. roum.	Moniteur du Pétrole Roumain.
Montan. Rdsch.	Montanistische Rundschau.
Nat. Petrol. News	National Petroleum News.
Nature	Nature.
Neft. Khoz.	Neftyanoe Khozyaistvo.
Nickel Ind.	Nickel Industry.
Nov. Neft.	Novosti Neftepererabotki.
Nov. Tekhn. Bur.	Novosti Tekhniki Bureniya.
Nov. Tekhn. Neft.	Novosti Tekhniki Neftedobvicki.
Oel u. Kohle	Oel und Kohle vereinigt mit Erdoel und Teer.
Oil Gas J.	Oil and Gas Journal.
Oil Wkly	Oil Weekly.
Ole, Fette, Wachse	Ole, Fette, Wachse, Seife, Kosmetik.
Olii min.	Olii Minerali.
Paint Mnfr.	Paint Manufacture.
Paint Technol.	Paint Technology.
Petrol. Engr	Petroleum Engineer.
Petrol. Tech. (A.I.M.M.E.)	Petroleum Technology (American Institute of Mining and Metallurgical Engineers).
Petrol. Times	Petroleum Times.
Petrol. World (L.A.)	Petroleum World (Los Angeles).
Petrol. World (Lond.)	Petroleum World (London).
Petrol. Z.	Petroleum Zeitschrift.
Physics	Physics.
Pipe Line News	Pipe Line News.
Proc. Amer. Petrol. Inst.	Proceedings of the American Petroleum Institute.
Proc. Amer. Soc. Test. Mater.	Proceedings of the American Society for Testing Materials.
Proc. Ass. Asph. Pav. Technol.	Proceedings of the Association of Asphalt Paving Technologists.
Proc. Instn mech. Engrs	Proceedings of the Institution of Mechanical Engineers.
Proc. phys. Soc. (Lond.)	Proceedings of the Physical Society (London).
Proc. roy. Soc.	Proceedings of the Royal Society.
Przeg. Chem.	Przeglad Chemiczny.
Przem. Naft.	Przemysl Naftowy.
Quart. J. geol. Soc. Lond.	Quarterly Journal of the Geological Society of London.

Abbreviated Title.	*Journal.*
Rds & Rd Constr.	Roads and Road Construction.
Rec. Trav. chim. Pays-Bas	Receuil des Travaux Chimiques des Pays-Bas.
Refiner	Refiner and Natural Gasoline Manufacturer.
Rev. Comb. liq.	Revue des Combustibles Liquides.
Rev. Pétrolif.	La Revue Pétrolifère.
Rev. sci. Instrum.	Review of Scientific Instruments.
Riv. ital. Petrol.	La Rivista Italiana del Petroleo.
S. Afr. Min. (Engng) J.	South African Mining and Engineering Journal.
Strade	Strade.
Sulz. tech. Rev.	Sulzer Technical Review.
Summ. Ops, Calif. Oil Flds	Summary of Operations, Californian Oil Fields.
Tech. Phys. U.S.S.R.	Technical Physics of the U.S.S.R.
Tekn. Tidskr.	Teknisk Tidskrift.
Terr. Magn.	Terrestrial Magnetism.
Trans. Amer. geophys. Un.	Transactions of the American Geophysical Union.
Trans. Amer. Inst. Min. & Metall.	Transactions of the American Institute of Mining and Metallurgy.
Trans. Faraday Soc.	Transactions of the Faraday Society.
Trans. Inst. mar. Engrs	Transactions of the Institute of Marine Engineers.
Trans. Instn min. Engrs	Transactions of the Institution of Mining Engineers.
U.S. Bur. Mines, Inf. Circ.	United States Bureau of Mines, Information Circular.
U.S. Bur. Mines, Rep. Invest.	United States Bureau of Mines, Report of Investigations.
U.S. Bur. Mines, Tech. Paper	United States Bureau of Mines, Technical Paper.
U.S. Geol. Surv. Bull.	United States Geological Survey Bulletin.
U.S.P.	United States Patent.
World Petrol.	World Petroleum.
Z. dtsch. geol. Ges.	Zeitschrift der Deutschen Geologischen Gesellschaft.
Z. Geophys.	Zeitschrift für Geophysik.
Z. prakt. Geol.	Zeitschrift zur Praktische Geologie.
Z. ver. dtsch. Chem.	Zeitschrift Vereins deutscher Chemiker.

(Certain periodicals listed above have not been available during 1942).

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Geology and Development.

1.* Possible Future Oil Provinces of the United States and Canada. A Symposium, edited by A. I. Levorsen. *Bull Amer. Ass. Petrol. Geol.*, Aug. 1941, **25** (8), 1433–1586.—Reserves in areas not fully explored, where big discoveries have yet to be made, are discussed, the criteria of possible oil occurrence being: (1) that there should be a thickness of at least 1000 ft. of sediments, especially of those which are marine, of contrasting types, and not metamorphic; (2) that there should be oil- or gas-shows, or lateral continuity with productive structures; (3) that there should be unconformities with pre-unconformity folding and weathering to produce oil-traps; (4) that there should be wedge-belts of porosity suitable for reservoir rocks. On accompanying sketch-maps and geological sections a simplified system of symbols has been employed. The work is intended to show in what parts of North America most profit is likely to accrue from intensive exploration by geologists. A. L.

2.* Possible Future Oil Provinces in Alaska. P. S. Smith. *Bull. Amer. Ass. Petrol. Geol.*, Aug. 1941, **25**, 1440–1446.—In Alaska special attention is directed by Philip Smith to the Jurassic and probably Miocene rocks of the south coast at Katalla and Yakataga, where wells as shallow as 1000 ft. have already acted as producers. Alaska Peninsula has yielded shows of high-grade oil. In the north-west foreland folding in front of thrusting from the south-west gives a wide area of anticlines, varying in closure in a sandstone, shale, and oil-shale terrain. Here the Cretaceous alone is about 20,000 ft. thick. A. L.

3.* Possible Future Oil Provinces in Western Canada. Alberta Soc. P.G. *Bull. Amer. Ass. Petrol. Geol.*, Aug. 1941, **25**, 1447–1456.—Big developments are indicated in Western Canada in the Palæozoic and younger rocks, 1000–13,000 ft. thick, lying between the foothills of the Rockies and the Canadian Shield, in an area 1600 miles from north to south and 800 miles wide at the United States boundary. Underneath the unconformable base of the Middle Devonian prospects are poor, but that formation is generally petroliferous and bituminous, and is producing at Fort Norman on the Mackenzie River. The top of the Lower Carboniferous Limestone yields at Turner Valley and Steveville, in South-west Alberta, where porous zones due to weathering are present at an important unconformity, above which Jurassic and Cretaceous sands also contain quantities of oil and gas. Exploration is rendered difficult by gentle dips and widespread glacial drifts. In Northern Alberta the "Athabasca" Oil Sands, in which heavy oil coats the grains and acts as matrix as well as pore-filling, cover an area of 10,000–30,000 square miles, ranging up to 225 ft. in thickness. They constitute the McMurray formation (Lower Cretaceous), formed as a great sand delta from the Canadian Shield, and rest on planated Devonian. Dips are to south and west at

3–8 ft. per mile, and the oil has escaped the pressure and heat of highly folded zones. Sufficient oil to fill a billion barrels is available, to be obtained by mining on benches along valleys. A hot-water installation for separating oil from sand has undergone tests, and is expected to produce 350 brl. a day. Refining plant will give a complete line of products. Seepages in Queen Charlotte Island and on the mainland of South-eastern British Columbia, all from the Jurassic, also seem hopeful. A. L.

4.* Possible Future Oil Provinces in Pacific Coast States. Pacific Section A.A.P.G. *Bull. Amer. Ass. Petrol. Geol.*, Aug. 1941, **25**, 1457–1468.—In Washington State luxuriant vegetation, deep weathering and volcanic dykes, and the boulder clay of Puget Sound often render prospecting difficult. On the western side of the Olympic Peninsula seeps and yields from Oligocene and Miocene are promising, and organic shales of equal age elsewhere merit examination. In Oregon anticlines in the Coast Range and buried structures in the valleys between the Coast and Cascade Ranges are likely places, but there seems to be a deficiency of source-beds. Tertiary and earlier embayments on the Californian coast present laterally varying shale and sand deposits that call for skilled stratigraphical work in order that more oil-traps may be found. The Sacramento gas-field, and the Salton Sea area, with its mud volcanoes and volcanic history, may yet furnish oil at depth. A. L.

5.* Possible Future Oil Provinces in Rocky Mountain Region. Rocky Mountain A.P.G. *Bull. Amer. Ass. Petrol. Geol.*, Aug. 1941, **25**, 1469–1507.—East of the United States Rockies there are many fields, from the Canadian border down to Northern New Mexico. They present sequences from Lower Palæozoic onwards. In Montana the "Disturbed Belt," partly covered by thrusting, has many anticlines, most of which have not been explored to sufficient depth. Potential source-rocks are present above the Madison Limestone (Lower Carboniferous), which has a weathered top like that which acts as a reservoir at Turner Valley, Alberta. In North-eastern Montana low folding in exposures and the necessity for deep drilling have held up development; at present Upper Cretaceous sands are producing, and oil has been proved in Upper Palæozoics. Strata at depth vary from homotaxials in the basin edges, and palæogeography is unknown. In Southern Montana similar factors and absence of success in superficial anticlines have also been deterrents, although seeps and wells on the fringe of the Powder River basin indicate reservoirs at depth in the centre. Absence of marked deformation of the Tertiary cover is also a handicap in the Big Horn basin, Wyoming, and in the Wind River and Green River basins. The last may have oil in lenticular sands as well as at depth. In Colorado and Utah depth and marketing conditions are both adverse. The north part of the Black Mesa basin has dry beds, and oil occurrence may be synclinal at Carboniferous to Cretaceous horizons. In the San Juan basin, New Mexico, little exploration has been done below the Dakota Sandstone (Upper Cretaceous), apart from one marginal well—Rattlesnake—which produces from the Upper Carboniferous, other mainly marine beds occurring underneath. A. L.

6.* Possible Future Oil Provinces of Northern Mid-Continent States. Tulsa Geol. Soc. *Bull. Amer. Ass. Petrol. Geol.*, Aug. 1941, **25**, 1508–1526.—In the northern mid-continental fields of North and South Dakota the dominant feature of the stratigraphy is eastward thinning and overlap, so that many longitudinal wedge-belts of porous material must exist. When markets are obtainable and hindrances due to glacial deposits and loose surface sand can be overcome, production is to be looked for from the Ordovician upwards. The anticlinal uplift of Central Kansas is continued north-west into Nebraska, and overlaps of pervious strata, as well as upfolds and sand-lenses due respectively to earth movements and contemporaneous erosion during Palæozoic deposition, appear felicitous. Until many more trial borings have been put down, however, neither seismography nor palæogeography can see through the cover of later rocks which have been tilted in both pre-Cretaceous and post-Tertiary time. In the Salina and Forest City areas, north-east of the Central Kansas oil-pools,

the thickness of marine strata and their overlap against the Nemaha ridge point to productivity, but many dry wells have been drilled. Southwards from Central Kansas to the Amarillo buried ridge in Texas is a region with a geological column up to 2 miles deep. Around the borders oil has been found from rocks of Ordovician to Permian age. From present knowledge, inadequate as it is, of transgressions and lateral changes in deposition, 1000 linear miles of porosity wedges can be inferred. Exploration is difficult, however, since the surface beds do not lend themselves to precise mapping, and at shallow depths there are evaporites which upset geophysical observations. In Oklahoma and Arkansas the Ouachita Mountains are overthrust northwards on to a geosynclinal accumulation of great depth. The Choctaw thrust-plane conceals pre-Upper Carboniferous beds of shale, chert, and sandstone of low porosity, Ouachita type; but farther north the Ozark or Arbuckle type appears with marine shales and limestone and sands of "Wilcox" character in the Ordovician. Wedges in the Devonian under the Chattanooga Shale also offer opportunities for concentration. Gas is yielded, but high-carbon ratios in the local Upper Carboniferous coals have been regarded as a contra-indication against much oil. Further trial wells are needed that will penetrate the whole Carboniferous system and below it.

A. L.

7.* Possible Future Oil Provinces of West Texas. West Texas Geol. Soc. *Bull. Amer. Ass. Petrol. Geol.*, Aug. 1941, **25**, 1527–1538.—In the Llano Estacado, West Texas, best prospects are in the basal Permian dolomite and in arkosic washes from the flanks of uplifts. Older beds with a profound unconformity between Ordovician and Lower Carboniferous, and with early Upper Carboniferous folding, are also promising. A cover of Triassic red beds is unprepossessing. Edwards Plateau, north of the Rio Grande, has an overthrust belt on the south under which anticlines in the Cambro-Ordovician Ellenburger Dolomite, already known to contain gas, and in the Lower Carboniferous, may yield oil. Farther north wedges in Upper Carboniferous sands which thin out northwards are reasonably certain, and also in Permian beds showing lateral variation. All the Palæozoic formations and the overthrust are covered by the Cretaceous deposits which transgress from the south, and are gently folded so as to obscure the structures below. Near Del Rio lenticular sands, in the Cretaceous, are yielding oil. In the Trans-Pecos River province are complicated basins in which oil is present from Lower Ordovician to Quaternary. Formerly inaccessible, the oil in the north-west corner is now within reach of two pipe-lines that cross the Diablo Plateau.

A. L.

8.* Possible Future Oil Provinces of Eastern Canada. Geol. Survey of Canada, Quebec Bur. Mines, Newfoundland Geol. Survey. *Bull. Amer. Ass. Petrol. Geol.*, Aug. 1941, **25**, 1539–1562.—On the eastern side of the Continent it is found that the gently folded Ordovician to Devonian sediments of the James Bay area in Canada seem to yield no seepages. In Eastern Ontario similar marine beds reaching as high as the Richmond (late Ordovician) have yielded oil and gas from Trenton Limestone (Middle Ordovician) and a black bituminous shale above it, chiefly from the west and south sides of a down-faulted block. On the Ontario Peninsula most of the oil is from Middle Devonian limestones, while gas is obtained from the Silurian and Middle Ordovician. In Nova Scotia and New Brunswick two main synclinals contain Lower and Upper Carboniferous beds, among which non-marine deposits predominate. The only petroleum-producing field is at Stoney Creek, and is from the Albert formation (Lower Carboniferous), which also contains oil-shales. Workable oil-shale also occurs near the top of the Upper Carboniferous at New Glasgow. In the Prince Edward's and Magdalen Islands there is a terrestrial lithology—*e.g.*, soft red sandstones and silts, gypsiferous beds, and volcanic tuffs. No seepages have been noted. In the Gaspé Peninsula folds in the marine Ordovician to Devonian beds are of medium intensity, and unconformities separate Ordovician and Silurian, and possibly Silurian and Devonian. Bituminous shales and oil-soaked limestones occur at several horizons. A recent deep well ended in 1940 at a depth of 5995 ft., but this fell more than 1000 ft. short of reaching a possibly oil-saturated layer in the Silurian. Likewise in Eastern

Gaspé favourable structures remain untested by deep boring. Underground porosity may be unsuitable, but exploration may be worth while as far west as the Matapedia Valley. In the St. Lawrence Lowlands, mainly Ordovician beds dip at low angles in the north, but become highly complex on the south-east side of the river. Gas has been found below the surface clay, and parts of the Trenton are petroliferous. Helgi Johnson describes petroleum occurrences at two Ordovician localities in Newfoundland —Parson's Pond and St. Paul's. In addition, there are oil-shales at Grand Lake and Piliers Bay in the Carboniferous, and bitumen seepages. But, as elsewhere in Canada, a thick glacial coating often makes geological surveying somewhat speculative.

R. C. W.

9.* Possible Future Oil Provinces in Eastern United States. Appalachian Geol. Soc. *Bull. Amer. Ass. Petrol. Geol.*, Aug. 1941, **25**, 1563–1574.—In the eastern part of the United States the Appalachian basin includes the Appalachian geosyncline and the Cincinnati arch. There are more than 10,000 ft. of sediments, and bituminous shales and marine magnesian limestones are conspicuous. Disconformities exist at the base of the Upper Carboniferous and beneath the Devonian. Beds which are yielding oil and gas include the Trenton (Ordovician), " Clinton Sand " (Lower Silurian), Newburg (Silurian), Oriskany (Lower Devonian). Upper Devonian to Upper Carboniferous pay-sands of the old Appalachian fields are now largely depleted. In North Cincinnati the possible oil area includes two major anticlines, the Cincinnati arch and the Kankakee arch separated by the Logansport sag. The sub-Trenton strata are insufficiently explored, and comprise, where the Cincinnati arch crosses the Ohio river, over 5000 ft. of sandstone, dark limestone, and dolomite. R. C. W.

10.* Possible Future Oil Provinces of South-Eastern United States. Mississippi Geol. Soc. *Bull. Amer. Ass. Petrol. Geol.*, Aug. 1941, **25**, 1575–1586.—In the South-eastern United States, in Georgia, several seeps are known, and oil-showings have been found in wells, but there is no commercial development, as few clearly defined structures have been worked out. Florida has thick marine sediments, mostly limestone, with large unconformities at the top of the Palæozoic and base of the Upper Cretaceous. Gas is reported in the Tertiary and more rarely in the Cretaceous, but no oil. Deeper Mesozoic and Palæozoic rocks are within reach of the drill. South Alabama has mainly marine sediments, with large pre-Upper Cretaceous unconformity. Gas is common, but dry wells on the Hatchetigee anticline and the Jackson fault have discouraged development. The Lower Cretaceous should be explored. North-west Alabama contains Cambro-Ordovician to Permian marine and lagoonal sediments, including much dolomite. There are asphaltic sands, and oil- and gas-shows, as, for example, in the old Fayette gas-field. The oldest shows are Ordovician. The deepest shows in Mississippi are also Ordovician, and an entire geological column of mainly marine origin is present, with pinch-outs, folding, and a few salt-domes. In Tennessee production has been obtained from many horizons. The Palæozoics of West Tennessee are, however, unexplored. Reasons for tardy exploration include: (1) loess surface cover, (2) fresh-water in Upper Cretaceous, (3) absence of younger Palæozoic in West Tennessee, (4) apparent lack of reservoir rocks above Knox dolomite (Cambro-Ordovician), (5) rapid decline of shallow Ordovician production, (6) restriction of present Ordovician and Mississippian production to small structures.

R. C. W.

11.* Geology of British Oilfields. 1. The Geology of the Assam–Arakan Oil Region (India and Burma). H. M. Sale and P. Evans. *Geol. Mag.*, 1940, **77**, 337–363.—The Tertiary rocks of the Assam–Arakan region are almost unfossiliferous, and that, coupled with difficulties of access, has rendered classification very difficult.

Drilling began in Assam in 1866, but little oil was produced until after 1922. The only oilfields of importance which have been found are Digboi and Badarpur, and they represent a poor return for the time and money spent on prospecting.

The Lower Tertiaries are of two types. In the north-west sandstones, shales, thin

coals, and some limestone occur, whilst the main development on the south-east side of the Assam valley and the Upper Surma Valley consists of shales, sandstones, and thin coals. The Upper Tertiaries rest unconformably on the Lower Tertiaries, and contain shales, sandstones, and pebble-beds.

The Tertiary belt of Assam–Arakan has been subjected to strong folding. In North-eastern Assam there is strongly developed thrusting. At the extreme south of the belt the long, narrow anticlinal folds disappear and are replaced by a much more complex structure.

Oil-seepages occur in beds from the top of the Lower Tertiaries through the lower half of the Upper Tertiaries. They are most numerous in Upper Assam, towards the head of the Surma valley, in the Boronga Islands, in Ramree Island, and in Cheduba Island.

The Digboi and Badarpur oilfields are on anticlines, and the same is true of many of the oil- and gas-seepages; but a number of Upper Assam seepages are closely associated with the overthrust strike faults of the Naga Hills. The asymmetrical Digboi fold is faulted on the steep flank. The Badarpur oilfield is developed on a small dome, also with a faulted steep flank. The very small productions of Boronga, Ramree, and Cheduba have been obtained from shallow wells drilled near to seepages, mostly on sharply folded structures. G. D. H.

12.* Geology of British Oilfields. 2. The Geology of the Oilfields and Some Prospective Oil Areas in Canada. G. S. Hume. *Geol. Mag.*, Jan.–Feb. 1941, **78** (1), 1–36.—On the Gaspé Peninsula the oil-bearing region is principally in the York and St. John River basins. Oil has been found in the Devonian, and a small production was obtained from wells drilled prior to 1902. Recently work has been renewed, and while there are favourable structures and petroliferous beds, the presence of suitable reservoir beds is still in doubt.

South of Moncton in New Brunswick, oil and gas have been obtained from the Albert formation (Mississippian) on the south flank of a fold. On the south-western peninsula of Ontario a little oil has been produced for eighty years. The basal arkose, possibly of Ordovician age, gives a little oil, and one field has been established in the Trenton (Dover). The latter may be due to faulting and fracturing having provided the necessary porosity. Gas and some oil are obtained from several Silurian horizons (Whirlpool, Cabot Head–Grimsby group, Guelph, and Cayugan). The Middle Devonian limestones are the most prolific sources of oil in Ontario, and in each Middle Devonian field the structure is an anticline of small closure.

Two wells yield oil in the Mackenzie River basin, 50 miles north of Fort Norman. Seepages of oil are common in the Upper Devonian, which is the productive horizon, and there are seepages in the Middle Devonian. The Middle Silurian is bituminous.

During 1939 96% of Canada's 7,743,000-brl. oil production came from Turner Valley in the foothills of Alberta. The structure of the foothills is complex, and the Mesozoic rocks, of which they are mainly composed, are highly faulted and folded, with great overthrust blocks in the Palæozoic. The Devonian yields oil in a well at Moose Mountain, and the overlying Mississippian contain limestones which provide the main oil- and gas-zones at Turner Valley. In the Southern Alberta foothills the Jurassic rests on the Mississippian, but to the east Triassic beds occur. In the lower part of the Blairmore of the Lower Cretaceous some oil and gas are found in a sand.

The soft beds of the Mesozoic show more complicated structures than the underlying more resistant Palæozoic limestones. Turner Valley is a fault-block cut off by major faults on both sides, with the Palæozoic limestone showing a westerly dip mainly. Gas has been found in the higher parts of the limestone, and oil to the west of the gas areas. The field is 17 miles long, and the northern limit is not yet known.

Several minor oil- and gas-fields occur in the plains of Alberta. At Steveville much gas and a little oil have been found in the Devonian, whilst Lower Cretaceous sands yield oil at Red Coulee.

The Palæozoic limestone is to be tested at Commotion Creek, British Columbia. G. D. H.

13.* Geology of British Oilfields. 3. The Oilfields of Burma. P. Evans and C. A. Sansom. *Geol. Mag.*, Sept.–Oct. 1941, **78** (5), 321–350.—The Burma oilfields lie in the north–south Tertiary basin bounded on the west and east by the Arakan Yoma

and the Shan Hills respectively, and most of the oil is obtained from fields lying on a single line of folding some 50 miles long. Hand-dug wells were giving an appreciable output in 1797, but the first mechanically drilled well was completed in 1889.

The stratigraphy of the Tertiary basin is described in some detail. The beds show a general tendency for a northward transition from marine to brackish and thence to fresh-water. The continental Irrawaddy beds rest unconformably on the Pegu in the oilfield region, and there is another unconformity within the Pegu separating Oligocene from Miocene beds.

The basin is affected by north–south and west-south-west–east-north-east folding trends, the latter dividing the main syncline into three basins which show stratigraphical differences. East of the main syncline is a belt of volcanic rocks.

Although the Tertiary rocks are supposed to have been laid down in a long, narrow gulf, bounded on the west by the Arakan Yoma and subdivided longitudinally along a line agreeing approximately with the volcanic belt, it is probable that in the earliest Tertiary the western shore was formed by remnants of Gondwanaland. Deposition kept pace with sinking until well into Oligocene times, when pronounced uplift occurred. In late Oligocene or early Miocene times there was transgression which may have involved some of the Arakan Yoma.

The Yenangyaung field is an elongated dome, slightly asymmetrical, with dip-faults. Oil is obtained down to 5000 ft. Singu is more asymmetrical, and the eastern flank is slightly overturned in places. It is faulted, and the most southerly fault has had an important bearing on oil accumulation. Apart from Yenanma all the other fields are on more or less asymmetrical domes or anticlines. The main producing fields give oil from the Oligocene (Pegu) chiefly, but there are Eocene and Miocene shows. In the main fields the oil is believed to have originated in the shales near the sands in which it is found, but there may have been fairly extensive lateral migration. G. D. H.

14.* California Production and Geological Conditions. Anon. *Oil Gas J.*, 30.10.41, **40** (25), A 38.—The following data are tabulated by fields, grouped according to districts: name of field; discovery month and year; number of producing wells at the end of September 1941; current daily average production; cumulative production to the end of August 1941; oil gravity; type of structure; average thickness of oil-zone; depth range. Maps show the locations of the fields, and there are detailed field-maps showing the distribution of wells in some of the San Joaquin Valley fields. G. D. H.

15*. Cross-Section and Field Data of Active Oil Areas—Southern San Joaquin Valley, California. Anon. *Oil Gas J.*, 30.10.41, **40** (25), 40 B.—The San Joaquin Valley lies between the Coast Ranges and the Sierra Nevada. Seepages of oil occur in the Jurassic, but during that period the rocks were intensely folded and intruded. Commercial quantities of gas occur in the northern part of the valley in the thick Cretaceous deposits, but depth precludes exploration except along the margin of the valley. From the Eocene onwards the valley was an area of sedimentation, with the oldest and youngest series predominantly continental. The Oligocene and Miocene are marine, with some of the Pliocene fresh-water or in the form of alluvial fans.

The valley has been a continuously subsiding area, giving a variety of structures of different ages, some of the folds being very recent.

The search for oil began on the margins of the valley, McKittrick being found on the western margin and Kern River on the east, followed by Coalinga and Midway–Sunset on the west. Fields now stretch right across the valley, and the discovery of those in the deeper parts was a consequence of geophysical work.

The oil-producing area embraces 3935 sq. miles, with 215 sq. miles proved for production. Nearly 2,400,000,000 brl. of oil have been produced, and the reserves are estimated at 2,100,000,000 brl.

A map shows the location of the oil- and gas-fields, and a cross-section indicates the stratigraphy, structure, and producing horizons. G. D. H.

16.* Natural-Gas Reserves Equal to Total Production to Date. Anon. *Oil Gas J.*, 30.10.41, **40** (25), A 48.—California has produced 7,837,582,539,000 cu. ft. of gas.

During the first half of 1941 only 3·6% of the gas output was wasted, a result due to gradually improving conditions in the past ten years. Most of the gas was obtained with oil, and whilst the Los Angeles Basin tops the list, the San Joaquin Valley group of fields will probably equal or surpass its output in 1942.

Dry gas is obtained from a number of fields and zones, but all dry gas does not originate in fields that produce dry gas exclusively. Rio Vista is the largest Californian dry-gas field. In the San Joaquin basin the gas comes from the Upper Pliocene as a rule. The Buena Vista Lake gas-field is on an anticline located by geophysics. Delano, another geophysically discovered dome, also gives gas from the San Joaquin clay series (Upper Pliocene). At Chowchilla gas was discovered at 8030 ft., 3800 ft. below the top of the Cretaceous contact. There is, however, a second gas zone at 2390–2800 ft. The Willows gas-field gives gas from the Cretaceous, but is not on commercial production. Marysville Buttes gas-field is on the south flank of the Sutter Buttes volcanic intrusion, and is productive from the Cretaceous. Buttonwillow is a gentle anticline with a closure of 250 ft. The McDonald Island gas-field lies on a dome discovered with the aid of the seismograph. Gas is derived from the Upper Cretaceous at Tracy, where the productive acreage is small. Vernalis, a recent discovery a few miles south of Tracy, has not yet had its possibilities fully determined. The Rio Vista production may be from the Eocene. Potrero Hills has not been put on commercial production. Goleta is an asymmetrical dome complicated by overthrust faulting, and giving gas from the Vaqueros.

Tables show the yearly gas production and its utilization, together with the oil output. A map gives the positions of some of the fields. G. D. H.

17.* Adequate New Reserves Found to Offset this Year's Output. L. P. Stockman. *Oil Gas J.*, 30.10.41, **40** (25), A 81.—Results of operations during the past three years indicate that operators should have found more than 230,000,000 brl. of new production annually, but they failed to do so, and hence crude-oil reserves have declined slightly during this period. Various factors affect production, and therefore reserves and ultimate recoveries.

The 1940 discoveries were Del Valle, the Pyramid Hills section of Kings County, and the Republic area in the Midway–Sunset district. Recently drilling on the extreme western end of the Del Valle structure has given several good wells, leading to the assumption that production may extend along the whole anticline from the Havenstrite section to the Videgain area. These areas are separated by a zone broken by folding and faulting.

The first discovery of 1941 was the Vernalis gas-field, followed by Panoche, Oak Canyon, Union Avenue, Raisin City, Helm, Jacalitos dome, Shafter, Dyer Creek, and Turnbull Canyon. The Panoche possibilities are undetermined, and success has not attended the second and third wells at Union Avenue. Estimates of reserves are apt to vary with the results obtained in a few successive wells; hence Raisin City's reserve of 5,000,000 brl. may be revised in the light of the latest well with an initial flow of 1224 brl./day. Only one well has been completed at Dyer Creek. Oil is apparently accumulated in the Miocene against a fault. The Shafter discovery well encountered a thin, tight producing zone. Three pays have been found at Helm, in the Cretaceous and Lower Eocene at 8000 ft., and the Lower Miocene at 7448 and 7000 ft. A number of wells have been drilled at Jacalitos in the past 20 years, but the first commercial producer was not drilled until 1941. The Turnbull Canyon discovery is north of the Whittier fault. It may produce from the Puente.

Although the Ford zone is not now being produced at Wilmington, it is possibly the most productive horizon of the field. Each fault-block at Wilmington is a separate unit. An Eocene shoreline accumulation has been developed east of the old East Coalinga field. Paloma is California's first distillate field. At Inglewood the Miocene is now being developed.

The crude-oil reserves and recovery per acre to date are tabulated by fields, and the production and demand in the period 1939–41 are given by months. G. D. H.

18.* California Crude-Oil Production from 1894 to Date. Anon. *Oil Gas J.*, 30.10.41, **40** (25), A 96.—The production, in barrels, year by year is tabulated for the various fields under the district headings San Joaquin Valley, Coastal district, Los Angeles Basin, G. D. H.

19.* Trenton Lime Production in Five Illinois Pools. Anon. *Oil Gas J.*, 30.10.41, **40** (25), 164.—The Trenton has given oil for a number of years from a few pools in South-east and South-west Illinois, and in 1940 and 1941 successful Trenton wells were completed at Centralia and Salem. Eighty-seven Trenton wells have been drilled at Salem, having been deepened from the Devonian. Trenton tests in a number of small pools have been unsuccessful, and so far it seems that Trenton production is limited to structures with considerable closure.

The first Trenton production in Illinois was in Kankakee County in 1900, but it was not commercial. The depth was 140 ft. Commercial Trenton production was discovered in 1910 at Westfield, a dome on the axis of the La Salle anticline. The 160 ft. of Trenton closure conforms closely to that of the overlying Mississippian. The permeability and porosity of the producing horizon were low, and hence the wells were small. Trenton production at Martinsville was obtained in 1921, but the two successful wells were small. At Waterloo and Dupo, on the northern extension of the Waterloo anticline, quite a number of Trenton wells have given oil.

The Trenton wells have been small, though long-lived, and the total Trenton crude obtained in Illinois is less than 1% of the State's total production. G. D. H.

20.* Well Logs and Field Data of Active Oil Areas, Upper Gulf Coast District, Texas. Anon. *Oil Gas J.*, 6.11.41, **40** (26), 144 p.—All the formations dip gulfward, and there is also considerable thickening of the older Tertiary beds, with the result that along the coast older Tertiary beds are now beyond the reach of the drill. The later formations are alternating continental and marine beds, with marine beds predominating in the middle of the section in the northern part of the area and throughout the whole section near the coast. The predominant structural features are a complex series of faults formed by slumping of blocks of sediment during the subsidence of the area, and a large number of salt-domes which have risen to various heights in the section. Recently there has been a search for local gentle structures forming small uplifts in areas of lensing sands.

Production began with the discovery of Spindletop in 1901, and during the next 25 years was largely confined to salt-domes and other fields discoverable by surface geology. The introduction of geophysics led to the discovery of many deep-seated domes and gentle structures on which many of the larger fields are located. There are more than 125 active fields in the district.

As older horizons have been found productive, prospecting has tended to spread northwards and deeper. It is now realised that the whole of the Wilcox may be oil-bearing, and recent tests have reported more than 1000 ft. of Wilcox sand, with almost one-third of the section showing some oil saturation.

A map, stratigraphical column, and a series of well-logs are given. G. D. H.

21.* Venezuelan Crude Production of 648,762 Brl. Daily Sets New Peak. Anon. *Oil Gas J.*, 20.11.41, **40** (28), 29.—During September Venezuela's daily average production was 648,726 brl., about 18,300 brl. above the August figure. A slight decline took place in the eastern fields, but the rise of 20,685 brl./day in the Maracaibo fields more than offset this. The output was 33% above that of September 1940. Lagunillas contributed most to the rise in output in September 1941. The Santa Barbara field yielded 4510 brl./day, against 2045 brl./day in August. Most of the new production from Eastern Venezuela is derived from comparatively new fields in Anzoategui–Santa Ana, San Joaquin, El Roble.

The output for September 1940 and for August and September 1941, is tabulated by fields and companies, and the exports by various companies are given for August and September 1941. G. D. H.

22.* Well Logs and Field Data of Prospective Oil Areas—North Section Permian Basin—West Texas. Anon. *Oil Gas J.*, 20.11.41, **40** (28), 52 p.—The north section of the Permian basin comprises an area of about 20,000 sq. miles between the productive part of the basin in West Texas and New Mexico and the Panhandle gas- and oil-field. Very few wells have been drilled in the area, and correlation between them has been difficult. The granite and schist basement of pre-Cambrian age was covered in the southern and eastern parts of the basin by Ellenburger–Arbuckle and Simpson

deposits. Silurian and Devonian deposits came in from the south-west. Mississippian and Pennsylvanian deposits cover the margins of the basin, but do not appear to have extended as far north as did the Ordovician beds. In the Permian a great thickness of limestone was deposited in the Texas section, followed by continental deposits. Salt, anhydrite, and gypsum beds were also laid down, probably behind limestone reef barriers analogous to the limestone mass of El Capitan, and these reefs have given most of the oil in West Texas.

In North-west Texas alternations of marine and evaporite deposits are most frequent, adding to the number of possible pay horizons and rendering discovery more difficult. The pays at Wasson and Slaughter are generally considered to be of San Andres age; that at Lubbock is probably of Clear Fork age, as in the Panhandle.

Pre-Permian production seems unlikely, and the massive limestone deposits of the older West Texas producing district appear to be absent. The seaward sides of the barriers, which gave the many evaporite series, provide possibilities for oil and gas accumulations.

A series of well logs is appended. G. D. H.

23.* Colombian Wildcat Produces at Rate of 480 Brl./Day. Anon. *Oil Wkly*, 20.10.41, **103** (7), 64.—Casabe 1 on the Yondo concession produced at the rate of 480 brl./day in a test. It lies on the left bank of the Magdalena, opposite the Barranca Bermeja refinery. Oil sands were reported at 6748–6993 and 7435–7602 ft. The depth is 8280 ft. G. D. H.

24.* Venezuela Output Reached New Peak in August. Anon. *Oil Wkly*, 20.10.41, **103** (7), 64.—The 19,769,000 brl. of oil produced in August was Venezuela's record output for any month, and 30% above the January figure. The Lake fields, Cabimas, Lagunillas, Tia Juana, and Bachaquero, had an increase of 33%, in spite of a material fall at Bachaquero. Mene Grande's output rose by 24%. 38% more oil was produced at Oficina, Jusepin, San Joaquin, and El Roble than in January. Mulato 1 on the Amana concession has proved a gasser, giving 1,200,000 cu. ft. of gas/day from 4100 ft. The closed-in pressure was 1575 lb./in.^{2}. There was a small show of oil.

Roble 5 gave 42·5° oil from 9805–9850 ft. at the rate of 1128 brl./day, and Roble 6 has had showings of oil and gas at 8900 ft. Mercedes 2 was making a drill stem test at 4616 ft. G. D. H.

25.* Alberta Basin Become Important Factor. F. R. Henry. *Oil Wkly*, 27.10.41, **103** (8), 40–42.—The Alberta basin, which lies principally in Alberta but has its southern tip in Montana, has yielded more than 100 million barrels of oil, 40 million from Turner Valley, and 68 million from Kevin-Sunburst, Cutbank, and Pondera. 46,000 brl./day are obtained, 27,000 being from Turner Valley. Recently a well on the Twin River structure of Southern Alberta has been giving 100 brl./day from 3900 ft. by pumping. The Madison was penetrated and showed porosities of 10–25%.

Twin River, Del Bonita, Spring Coulee, and Ross Lake are domes on the flank of the geanticline of which Kevin-Sunburst forms the crest. Kevin-Sunburst and Cutbank are flat structures with thin oil zones, giving small wells and a low yield per acre. The Alberta structures are more basinward and have steeper dips and greater closures. The oil zones are thicker and the reservoir pressures higher.

None of the Southern Alberta structures has yet produced from the sands of the Lower Blairmore, which are productive at Cutbank. Two wells at Spring Coulee showed these sands to be oil saturated. The Devonian, which underlies the Madison, affords deep possibilities.

The west flank of the Alberta basin is sharply folded and complexly faulted, and Turner Valley is the only field yet discovered in this area. G. D. H.

26.* Modern Prospecting a Broad and Complex Science. W. L. Baker. *Oil Wkly*, 3.11.41, **103** (9), 97.—The use of geology in prospecting for oil did not amount to much until about 1912, when the geologist's work was strictly surface structural mapping, a technique which continued to be the dominant prospecting method until the early 1920's. Thereafter it declined in importance, due to exhaustion of areas suitable for its application and the appearance of other successful methods. Stratum

contouring, the search for surface indications, and the following of trends preponderated in the geological work, although there was still much random drilling based on seepages and other surface evidences. Aerial photography, introduced since 1920, has added to the capabilities of surface mapping.

The sharp increase in consumption and the scarcity of new surface indications in the early 1920's caused more attention to be paid to subsurface geological methods. The correlation of well logs to provide subsurface maps and the development of ideas about favourable structures for oil accumulation came to the fore. The core-drill was of great value. Subsurface methods were at their peak between about 1925 and 1930, since when they have declined in importance as a discovery method.

The first salt-dome and oil-structure discovered geophysically was the Nash dome in Texas in 1924. This was followed, when it proved productive in 1926, by an intensive campaign of torsion-balance surveys, especially in the salt-dome country. The seismic refraction method gradually supplanted the torsion balance, and was highly successful in the Gulf Coast salt-dome region from 1924 to the early 1930's. About 1931 the reflection method came into use on the Gulf Coast, and is the leading exploratory method to-day. The gravimeter has almost replaced the torsion balance, and attained an all-time high in 1940. The use of the magnetometer has increased, although it is still but little employed. Electrical methods have received some attention, especially where the reflection method is inapplicable.

Appreciation of the possibilities of stratigraphic traps called for a revisal of prospecting methods which sought structural traps only, and the determination of palæogeography from detailed well studies and other data began to develop. Electrical logging has proved of great value in this connection, and has recently been supplemented by gamma-ray well-logging for cased holes. Core analyses have provided additional information on the porosity, permeability, fluid content, and age of the rocks, and various drilling records are proving helpful.

Geochemical prospecting claims to be able to discover structural and stratigraphic oil accumulations. G. D. H.

27.* Twin River Wildcat Shows for Production. Anon. *Oil Wkly*, 17.11.41, **103** (11), 62.—Twin River No. 1 in Alberta is giving 50–60 brl. of light crude per day from a limestone at 3969 ft. The well is 50 miles south of Lethbridge and 6 miles north of the Montana border. It is 10 miles north of the Reagan Tribal well of Montana, which found a flow of 5,000,000 cu. ft. of gas and a spray of oil in the Madison. G. D. H.

28.* Exploratory Activities in Brazil. Anon. *Petrol. Engr*, Oct. 1941, **13** (1), 75.—A small commercial output of oil has been found in the coastal area of Brazil around Bahia. Oil was first discovered in 1939 at Lobato at a depth of 700 ft. Since then at least ten wells have been drilled, of which two or three are commercial producers. The producing wells are slightly less than 2000 ft. deep, but some exploratory wells have been taken to 7000 ft. The oil is obtained from Cretaceous beds in a narrow belt of sediments some 20 ml. wide, with Quaternary and Tertiary beds resting on Cretaceous to Triassic beds.

Other areas of petroleum interest in Brazil are the Parana basin, Acre, and Para. A number of wells have been drilled in the Parana area, south of Rio de Janeiro. The Acre area is relatively near to the Aguas Calientes field of Peru, and there are seeps in Peru near the Brazilian border. The few wells drilled in the Para area gave little information on the oil prospects. G. D. H.

29.* Development of Aguas Calientes, East of the Andes, is Most Interesting Current Activity in Peru. Anon. *Petrol. Engr*, Oct. 1941, **13** (1), 96.—Five well have now been completed at Aguas Calientes at depths of about 1200 ft., with productions of 250–2500 brl./day. The temperature of the oil is 165° F., and the wells flow by water-drive with no gas. A 45-mile pipe-line may be built to carry the oil to the Ucayali River, and a small topping plant is to be constructed.

The structure runs north-west–south-east for about 15 miles, and it is about 7 miles wide. The crest is flat and relatively wide, and the north-east flank has dips as steep

as 25–30°. Oil is obtained from sands in a series of interbedded shales, sands, grits, and volcanic ash.

About 80% of Peru's oil comes from the Negritos district, and 139 wells were completed there in 1940. Most of the wells were in proved areas, although some were drilled to horizons not previously exploited, and a few were wildcats. The oil is obtained from the Eocene, but a deep test has been drilled to the Upper Cretaceous.

During the past year the output of the Lobitos area probably declined by about 10%. The old Zorritos field has about 60 wells, with a production of approximately 200 brl./day. G. D. H.

30.* Drilling and Production Activity in Foreign Fields. Anon. *Petrol. Engr*, Oct. 1941, **13** (1), 150.—Argentina's 1940 production of 20,610,000 brl. was 11% above the 1939 output. 70% of the oil came from Comodora Rivadavia. A deep test to 7715 ft. in the old central area found no production below the zones previously known. A wildcat in the southern part of the new El Tordillo area will be kept as a reserve for future development. 90 miles south-west of Comodoro Rivadavia, a well drilled to 6139 ft. found no productive formations, and two wells south of Comodora Rivadavia in San Jorge gulf were also unproductive. Some of the wildcats in the Plaza Huincul district had oil and gas showings. The Tupungato production has increased. Production is obtained at 7220–7890 ft. in the Lunlunta field.

25,600,000 brl. of oil were produced in Colombia in 1940, an increase of 7% over the 1939 output. 84% of the oil came from Infantas and La Cira. There are now approximately 100 producing wells in the Petrolea field, only one being on the south dome. There are three producers at Carbonera and ten at Rio de Oro. A small producer was completed at 3960 ft. at Tres Bocas, and a deep test has had slight showings.

Oil impregnation has been found in cores at various depths from 4900 to 6050 ft. in Casabe 1, across the Magdalena from Barrança Bermeja. Last year several wildcats were abandoned in the Magdalena Valley from south of Gamarra to Honda.

75% of Ecuador's production last year came from Ancon.

186,134,000 brl. of oil were produced in Venezuela in 1940, 9·4% less than the high of 1939. 73% of the oil came from the Maracaibo basin. In Eastern Venezuela both Santa Barbara and Socororo can now be considered proved fields.

The 1940 production of Iran, Iraq, Bahrein, Saudi Arabia, and Turkey is estimated at 122,800,000 brl. Burma produced 7,979,000 brl. of oil in 1940, and India's production was 2,250,000 brl. In 1940 the Netherlands East Indies produced 60,830,000 brl. of oil, Sarawak and Brunei 7,047,000 brl., and Japan 2,639,000 brl. G. D. H.

31.* Drilling Operations in the Philippine Islands. W. A. Sawdon. *Petrol. Engr*, Oct. 1941, **13** (1), 150.—Five wells have been drilled to depths of about 1000 ft. on the Bondoc peninsula of the Island of Luzon without finding oil production. A well has been drilled to 6000 ft. on the Daan Bantayan Peninsula of Northern Cebu, and this is to be deepened. The structure is a symmetrical anticline with a thick oil-bearing series, according to cores. In some areas of the Phillippines the marine Miocene and Pliocene beds are stratigraphically equivalent to the producing horizons of Borneo. In addition to the structures at Bondoc and Daan Bantayan, there are other folds with oil possibilities. Seepages are found in a number of places in the islands, particularly on the Bondoc peninsula. Shallow holes in an outcrop on the west coast of Cebu, 60 miles south of the Daan Bantayan location, have given oil. An exposed tar-sand on the island of Leyte has been mined for paving material.

The paper also describes the difficulties in transportation and haulage experienced owing to the lack of equipment. Details are given of the rig and methods used.

G. D. H.

32.* Elements of Argentine Petroleum Geology. Anon. *World Petrol.*, Sept. 1941, **12** (9), 77.—Commercial accumulations of oil and gas have been found in structures developed in the Sierras Subandinas in Salta and Jujuy, in folds which flank the Cordillera of the Andes in Mendoza, in anticlines along the northern limit of the Patagonian Massif in Neuquen, and in complexly faulted anticlines in Chubut within the Cuenca de San Jorge. Numerous oil-seeps, asphalt, etc., occur in these and other areas. The age of the producing rocks ranges Devonian to Tertiary.

In northern Argentina the fields of Aguas Blancas, San Pedro, Rio Pescado, Tartigal, and Lomitas-Tranquitas give oil from closely folded anticlines trending generally north–south. The outcropping formations are largely shales and sandstones of Cretaceous and Tertiary age. Production is usually limited to the axial parts of the folds, and at Vespucio and Tranquitas the producing sands are probably of Lower Tertiary age. Rio Pescado obtains oil from younger Tertiary sands, and Aguas Blancas from the Devonian.

Four important oil areas exist in Mendoza—Cacheuta, Tupungato, Lunlunta, and Ranquil Co. Cacheuta is on a plunging anticlinal nose, and the producing formations (Rhætic) outcrop near asphalt deposits. Tupungato is anticlinal, and originally yielded oil from shallow Tertiary beds, but the main production is from the Rhætic at about 5850 ft. Oil is obtained from very fine grained sandstones and from joints in interbedded volcanic ashes. Beds of Rhætic age on one of the domes on an anticline are productive at Lunlunta. At Ranquil Co. oil is obtained from Lower Cretaceous dolomitic limestones on an anticline.

Rapid lateral changes in lithology and structural complexities make the Neuquen geology difficult to unravel. There are at least three important post-Triassic unconformities. Oil indications are numerous. Although the five oil-pools are related to east–west folds, porosity and truncation are important locally in forming traps. Production is chiefly from the Jurassic.

Chubut is the most important oil-producing province, oil having been discovered in 1907 when drilling for water. The Comodoro Rivadavia area obtains oil from four zones of Upper Cretaceous sandstones and lenses which are partly continental, at depths of 1800–5850 ft. Lenticularity dominates the oil distribution. There are accumulations in places on complexly faulted anticlines trending east–west.

G. D. H.

33.* Petroleum Development against Historic Background of Ecuador. H. K. V. Tompkins. *World Petrol.*, Sept. 1941, **12** (9), 80.—Eastern Ecuador has favourable structures and Cretaceous beds are present, but the isolation will be a problem if oil is discovered there. In the lower portion of the plateau country, between the two mountain ranges, seepages are present, but the intense folding and fracturing are unfavourable features. The coastal area involves Tertiary beds from which oil is produced, and towards the mountains there are Cretaceous possibilities. Although there are seepages and suitable structures in various areas, production is limited to the Santa Elena peninsula. In the shallow wells in the seepage area, oil comes from fractures. Oil is obtained from two Eocene horizons at 1200 and 3800 ft. Wells are erratic, and output from the wells depends on the amount of fracturing of the sandstones. Many of the deeper wells are long-lived. Water is absent in the shallow horizon and there is little gas.

During the past two years there has been an increase in exploratory activity, and the whole of the coastal area is covered by concessions for exploration or exploitation. Off-shore from Cabo San Francisco, there appears to be an important seepage.

Some description is given of the country and its people, and the main points of the mineral and hydrocarbon laws are noted.

G. D. H.

34.* Growing Export Demand Stimulates Drilling in Venezuela. Anon. *World Petrol.*, Sept. 1941, **12** (9), 84.—In the first half of 1941 Venezuela's oil production averaged 563,766 brl./day, as compared with 508,000 brl./day in 1940. 27,000 brl./day of the increase was due to the Maracaibo fields, and 20,000 brl./day to Oficina. There are now 30 oil-fields in Venezuela, Santa Barbara and Guario having been added to the list this year.

Of the thirty-four wildcat operations in 1940, ten were abandoned, seven were brought in as producers, and nine were still being drilled at the end of the year. Four were being tested or cored.

30,000,000 brl. of oil were processed in Venezuelan refineries in 1940, 98·25% more than in 1939.

In the west the most important operations at present are in the Netick field, 42 miles north-east of Totumo. A well has been brought in for 500 brl./day of 28·1° A.P.I. oil. Las Ollas 1 in Central Venezuela may be completed as a distillate well. Rincon

No. 1, drilled to more than 9600 ft., has been completed as a producer. The Santa Ana field to the north has two producers giving 500–600 brl./day, while still farther north, at San Joaquin, 8000 brl. of oil/day are being obtained from fourteen wells. Guario has two producers and two wells ready for testing. Four wells are yielding 6000 brl. of oil/day at El Roble, and Santa Rosa provides 500–600 brl./day from one well.

60,000–70,000 brl./day are being shipped from Oficina by the 16-inch pipe-line. Early this year a 4000 brl./day producer was brought in at Santa Barbara.

G. D. H.

35.* Government Endeavours to Check Decline in Peruvian Production. Anon. *World Petrol.*, Sept. 1941, **12** (9), 88.—The Zorritos field gave 5500 brl. of oil during 1884 and had produced 3,287,000 brl. of oil up to the end of 1940. The producing sands lie at depths of 300–1700 ft. To the south are the Restin–El Alto and Lobitos fields, which have yielded more than 49,060,000 brl. of oil. There the producing horizons are at 1500 ft. and 2800–3200 ft., and a third horizon is being explored below 5000 ft. The most important Peruvian oil area is the La Brea–Parinas estate still farther south. Commercial production began about 1890, and up to the end of 1940, 211,962,000 brl. of oil had been obtained. Quaternary beds partly cover Tertiary sandstones, shales, and conglomerates, interbedded with which are oil-sands. The broadly folded rocks have been affected by many faults, giving rise to numerous blocks dipping at 5–35°, and commonly towards the east. Oil occurs at various horizons from 300 to 5000 ft. There are unconformities, with the consequent masking of the structure of the older beds in places.

From 1906 to 1915 some 286,000 brl. of oil were produced in the Pirin field of the Lake Titicaca district. Five wells have been drilled in the Agua Caliente area of eastern Peru, and initial outputs of 500–2000 brl./day were obtained from a depth of about 1100 ft.

The total oil output of Peru has declined since 1937.

The history of some of the oil development is briefly outlined, and the economic position and some of the activities of the oil companies are described. G. D. H.

36.* Tempo of Development Maintained in Colombia. E. Ospina-Racines. *World Petrol.*, Sept. 1941, **12** (9), 94.—From 1st Jan., 1939, to 30th June, 1941, twenty-eight wildcats were drilled in Colombia. Fifteen were abandoned, and of the six which found oil, only one exceeded 50 brl./day. Casabe No. 1 had oil and gas showings.

Tables give the wildcats drilled between 1st Jan., 1939, and 30th June, 1941, and the results obtained; the numbers of wells on the Barco and De Mares concessions; the production and disposal of the oil from these two concessions in 1940 and the first half of 1941; some of the properties of the oils from the Barco and De Mares concessions; the oil industry's contributions to the Colombian Government in 1939; the cost of locating a drilling rig in the Upper Magdalena Valley and of exploration and drilling in certain concessions. A map shows the concessions. G. D. H.

37.* Two Thousand Four Hundred Brl. Well 30 Miles North of Coalinga Opens Important New California Area. Anon. *World Petrol.*, Sept. 1941, **12** (9), 100.—In June 1941 a test in a well near Raisin City gave oil at a rate of 2400 brl./day from a Miocene sand at 5021–5049 ft. After sand trouble the well was finally finished with an output of 750 brl./day of 23·5° A.P.I. oil. The drilling followed intensive geological and geophysical studies. The first well was drilled to 6429 ft., and plugged back for 15,000,000 cu. ft. of gas/day from the Miocene at 5005–5045 ft.

The Raisin City anticline trends north-west, and lies on the east side of the main San Joaquin Valley syncline. Continental sands and clays form the first 3800 ft. of beds, followed by 600 ft. of rather coarse marine Miocene sands. From 4400 to 6000 ft. there are continental Miocene green and brown mottled clays with thin sand streaks, and the present production is from sands at about 660 ft. below the top of this interval. The Kreyenhagen shales lie at 6000–6300 ft., and below are Eocene sands.

G. D. H.

Drilling.

38.* Well-Drilling Methods. J. J. Conry. *Oil Wkly*, 3.11.41, **103** (9), 63.—This issue of the *Oil Weekly* reviews the petroleum industry over the last twenty-five years, and in this paper drilling methods and their modification in twenty-five years are discussed.

Even a casual backward glance over the past twenty-five years in oil-well drilling recalls two conflicting situations. One is the striking contributions of the scientist and the engineer to remarkable improvements in drilling equipment and methods. The other is the unmistakable fact that fundamentally methods have not been changed, merely refined. A typical example illustrating both points is the cable-tool rig.

Progress in cable-tool and rotary rigs and in mud systems is reviewed. A. H. N.

39.* Drilling Equipment. Anon. *Oil Wkly*, 3.11.41, **103** (9), 77.—In an extensive paper the development in drilling and production equipment over the last twenty-five years is reviewed. Derricks, prime movers, hoisting equipment, rotation mechanism, drilling strings, rotary mud systems, drilling control equipment, cable-tool drilling, directional drilling, coring improvements, cavings, etc., are studied separately.

In cementing, recently, a device for measuring and recording the irregularities and cavities in open holes has proved helpful in determining the amount of cement required to fill a given distance behind the casing. Some surprising variations in diameter of holes have been found in some formations, which probably accounts in many instances for the previous failure of cement to rise behind the casing as far as calculated.

In recent years there has been a growing use of gravel packing as a means of protecting screens against clogging, crushing, or excessive cutting action. Gravel packing is applicable either with perforated casing or screens, or by prepacked liners that have made their appearance on the market.

A recent innovation in completion practices has been the use of acid-soluble and drillable pipe sections. Set opposite upper producing zones, they provide a means of easily and efficiently opening them up for production at later dates.

In production similar treatment is given to various items of equipment. Several new pumping methods have been introduced. One is a hydraulically-operated rodless pump that is gaining much favour in the last few years. Oil pumped under pressure from the surface down a small tubing string actuates a bottom-hole pump. Submergible electrical centrifugal pumps, in which a motor placed in the hole is supplied with electric power through special cables from the surface, have been developed and used successfully in many regions. A. H. N.

40.* Fluorescence Analysis of Drill Core has Wide Possibilities. J. de Ment. *Oil Wkly*, 17.11.41, **103** (11), 62.—Petroleum and a variety of mineral species may be detected by the fluorescence they exhibit as ultra-violet light. Recently scheelite (calcium tungstate) was detected by the fluorescence of cores obtained in prospecting an antimony deposit in Idaho.

Petroleum generally fluoresces a characteristic blue or shade of blue; zinc minerals vary in their fluorescence, but uranium is practically always characterized by a yellowish-green response. The fluorescent test is very sensitive.

Some details are given of the fluorescence shown by tungsten, zinc, uranium, and mercury minerals, and by petroleum and its derivatives. G. D. H.

41.* Improvements Continue in Drilling and Production Practices in California. T. P. Sanders. *Oil Gas J.*, 30.10.41, **40** (25), A 30.—In an extensive paper drilling and production practices of California are reviewed. California uses the world's largest drilling equipment. One rig, owned by the Superior Oil Co., makes use of five 130-h.p. locomotive-type boilers which deliver superheated steam at 500-lb. pressure. It is believed that this is the first instance in which steam pressures of more than 350 lb. have been used in the drilling industry. At 500 lb. pressure the saturated steam temperature is 467° F., and with 100° of superheat the steam is hot enough to char wood. Under heavy firing the five boilers are capable of delivery power to the hoist-engine and pumps at the rate of about 1500 b.h.p.

Continental Oil Co. uses a large unitized steam-generating plant consisting of two marine-type water-tube boilers with complete facilities for condensing all the exhaust

steam for return to the boilers. The water-tube boilers are 13 ft. in over-all height and 8 ft. wide, but each is guaranteed to deliver at least 17,500 lb. of steam/hr. at 350 lb. pressure. Based on heating surface alone, each boiler is rated at 175 b.h.p., but under efficient firing the rating is exceeded by 310%, and with excessively heavy firing even more power could be developed. The plant is given in detail. Other systems of steam-generating plants are also described.

One new type of screen for removing sand and cuttings makes use of a large drum which is wrapped with wire around the outside to form fine slots. It is rotated and vibrated by an electric motor. Mud enters the inside of the drum through a hopper-like arrangement and passes through the mesh into a lower trough. Rollers at the top of the drum, made of rubber and fabric, force cuttings that become lodged in the slots back into the drum, so that they can be discharged from the interior with the other cuttings.

A number of California rigs now use a type of centrifugal desander in which the fluid is pumped in at high velocity by a motor-driven centrifugal pump located outside the mud-chamber. In circulating within the chamber the sand is driven to the outside, so that it finds its way downward to the bottom of the cone-shaped vessel, where it is taken off through an orifice of selected size. A small jet of water just above the orifice helps to wash the sand from the mud. A small but steady stream of sand, so fine that it has passed through the vibrating screens, is thus removed from the bottom of the chamber with little escape of mud. Testing and pumping mud are described in some detail.

A new type of derrick is widely used in California and in those foreign fields for which equipment is ordinarily purchased in California. It is a 136-ft. derrick with a bulge on one side extending from the third girth to a point above the fourble board. This bulge makes it possible to place three or four more rows of drill-pipe back of the finger-board. Thus the 136-ft. derrick provides about as much pipe-racking space as the 150-ft. derrick of standard design.

Weight control, use of internal-combustion engines, electric rigs and types of bit and hole size are discussed separately, new practices being pointed out. Bulk cementing, a new process, and new methods of improving cement bonds are given.

A new completion method is described where gas oil is squeezed under 900 lb./sq. in. into the formation. After completion of the washing and squeezing operation, the well was swabbed in the tubing for nearly 12 hrs. During this swabbing the casing pressure built up to 500 lb., and flow through the tubing started against a back pressure of 140 lb. The well was found capable of flowing unaided at a rate of 100 brl./day of 31-gravity oil through a 10/64-in. surface choke—a considerable improvement on the former production. Thus it appears that a new practice has been developed which make take its place beside acidizing and shooting as a means of increasing production. Other production practices are given. A. H. N.

42.* Causes and Prevention of Drill-Pipe and Tool-Joint Troubles. Part 1. R. S. Grant and H. G. Texter. *Oil Gas J.*, 6.11.41, **40** (26), 161. *Paper Presented Before American Petroleum Institute.*—It is stated that true twist-offs, spiral tears, and tension failures have been practically eliminated by improved pipe manufacturing and drilling practices. Failures at the last-engaged thread and leakage through threads have also been practically eliminated through improvements in design and in installation methods.

Fatigue breaks are the most common type of drill-pipe trouble to-day. They may be pure fatigue failures, but more often are accelerated by notches or scars and by corrosion. Fatigue breaks may be greatly reduced by the use of adequate drill-collar weight, and this is probably the most important recommendation that can be made to increase the life of drill-pipe.

Troubles arising from worn pipe can best be prevented by keeping the pipe straight. Pipe is usually made crooked by running the string in compression. Collapsed pipe, although rare, usually occurs while making drill-stem tests. Wall eccentricity, internal erosion, and magnetism, although often discussed, have never been proved to be causes of drill-pipe failures.

Longitudinal splitting of the pipe-ends of tool-joints has been practically eliminated by the use of upset forgings. Splitting or swelling of the pin and box-ends can be prevented by the use of special lubricants. Galling and wobble failures are the two

most common tool-joint troubles to-day. The former can be prevented by careful breaking in and adequate lubrication.

Wobble failures result from operation of the joint while loose, and aggravated by the modern practice of running drill-strings in tension. The best method by which these can be prevented is by adequate tonging and by care in handling to prevent damage to shoulders.

Tool-joint wear cannot be prevented, but the effects and costs entailed can be minimized by the use of easily replaceable tool-joints, oversize tool-joints, or wear-subs, and by resleeving or hard-surfacing of either the tool-joints or subs. A. H. N.

43.* Drill-Pipe and Tool-Joint Troubles—Their Causes and Prevention. Part 3. R. S. Grant and H. G. Texter. *Oil Gas J.*, 20.11.41, **40** (28), 51. *Paper Presented Before American Petroleum Institute.*—This forms the conclusion of the paper. The discussion on handling and correct use of drill-pipe and tool-joint is concluded by a series of summarized hints and advice collected from field experience and observation.

A point often forgotten is that a drilling string may sometimes be subjected to abuse merely in one well, or by only one crew, and later used normally; but troubles may continue to develop throughout the rest of its life. A simple example would be where one crew, being very careless in stabbing, damaged a number of the tool-joint box shoulders. This could lead to a succession of wobble failures and mud cutting throughout the whole string. A. H. N.

44.* Plugging-Back by Squeeze-Cementing in Open Limestone Formation. I. V. Tuyl. *Petrol. Engr*, Oct. 1941, **13** (1), 29–30.—This type of work has hitherto been hampered owing to the lack of a cement retainer that would remain "tight" when set in an open formation. The success obtained in the method now being employed is largely dependent, therefore, on the improved cement retainer designed for this type of cementing. This improved retainer has now been used on a total of six jobs without a single failure on the part of the retainer itself.

The retainer designed for the initial trial described in this paper consisted of a rubber element 5¾ in. in diameter and 30 in. long, to be run in a 6¼-in. hole. This packing element is collapsed vertically and expanded horizontally by raising the tubing when the retainer is at the desired depth in the well. A mandrel above the packing element causes the slips to expand horizontally, thus engaging the formation.

When a packing element is collapsed by the weight of the tubing, the total force is limited by the dead weight of the pipe in the medium in which it is suspended. When collapse is obtained by raising the tubing, as in the retainer, the force limit is determined only by the tensile strength of the pipe. For example, in a 3900-ft. well employing 2-in. external-upset tubing, the total weight available for collapsing the conventional packer is approximately 18,000 lb. in air or 15,600 lb. in water. On the other hand, the strength of Grade D (A.P.I.) tubing is 37,000 lb., assuming a safety factor of 2½. Also, when a packing element is collapsed by tensile stress in the tubing, any pressure applied below the element will cause it to set more tightly, rather than to move upward, as in the conventional packer.

An additional and important advantage is that no anchor is required below the retainer, and consequently the cement plug may be drilled out with greater ease.
A. H. N.

45.* Directional Drilling as a Routine Method of Development. W. A. Sawdon. *Petrol. Engr*, Oct. 1941, **13** (1), 36.—Operations in a tide-water lease lying entirely under the Pacific Ocean at Huntington Beach, California, are described. The average elapsed drilling time per well has been 34 days. Regardless of the depth, it has been found that it takes approximately the same number of days to drill any well on this particular lease. The reason is that the deeper wells extend over a greater horizontal distance and require greater angles; in building up the higher angles, more weight has to be applied, and in using greater weight, faster hole is made. In drilling some of the wells the rate of penetration has averaged 150·8 ft./8-hr. working day. In drilling the thirty-eight completed wells there has been a gain of 4878 ft. of oil-sand, or an average of 128 ft./well.

All holes are drilled with a gradual build-up to the maximum angle of deviation, and

every change in angle or direction is made with a smooth curve, to eliminate any chance of "dog-legs" that might eventually make trouble in running casing, or cause wear on rods and tubing when the well is put on the pump. This necessitates constant attention to the instrument that indicates and records the weight on the bit, the speed of rotation, the mud pressure, and the torque on the drill-pipe, as control of the drift angle is made possible by regulation of these factors.

Whipstocks are used mainly to change direction, as regulation of weight on the bit, speed of rotation, and pump-speed will definitely control the drift-angle. In this field it is the natural tendency of formations to control direction of drift and to raise and lower the angle from vertical. When building up the angles, the hole tends to go to the right; when lowering the angle, it tends towards the left.

In some wells only one whipstock has been necessary, all other controls being obtained with weight, table speed, and pump. The whipstock employed is of the removable type, and in drilling thirty-eight wells, 168 of these whipstocks have been set, an average of 4·4 per well. The average depth drilled per whipstock has been 1102 ft. In drilling at an angle of 52° from vertical the maximum turn-off from a whipstock is approximately 5° in direction, but in drilling these high-angle wells the average turn-off taken is about 3°, in order to make sure that no abrupt bends will result and cause friction.

The wells that are to bottom at sand locations closest to shore are drilled vertically to 750 ft. and the surface string there cemented. The first whipstock is then set at approximately 820 ft. The wells drilled farther out below the ocean are kept vertical to only 200 or 225 ft. and a whipstock is there set to start deflection. These holes usually build up to 12° from vertical before the surface string is run at approximately 750 ft. In all wells the drift angle is built up to the maximum within the first 2400 ft. of depth. In doing this it is endeavoured to build 2° 30′/100 ft. of depth.

The tools used in building up to maximum angle consist of the bit, a 5-ft. reamer, and an 8-ft. drill-collar. After reaching the maximum drift-angle the drill-collar is increased to approximately 30 ft., as this length will hold the maximum angle better.

Tabulated data give many exact details required in successful directional drilling.

A. H. N.

46.* Cementing and Completion Methods in Trinidad. P. E. T. O'Connor. *Petrol. Engr*, Oct. 1941, **13** (1), 83.—The excessively high pressures encountered in Trinidad at relatively shallow depths necessitate the use of drilling mud weighing as much as 135 lb./cu. ft., and occasionally as high as 140 lb./cu. ft. when drilling to the Lower Cruse sands. Even in the Forest and Upper Cruse sands it is often necessary to carry mud weighing 120–130 lb./cu. ft. Mud technique in Trinidad has therefore had to be developed to a very high order. All the major companies employ a mud specialist, with the required number of assistants, who is responsible for research as well as routine tests on drilling mud at the wells. Central mud plants are installed in all active areas where muds of various specifications are reconditioned and supplied to the drilling wells through a system of pipe-lines.

Viscosity control of these heavy muds is the principal problem, but with proper supervision even the heaviest muds employed can be maintained at a viscosity of 25–50 sec. (Marsh funnel, 1000 c.c. in and 500 c.c. out). The maintenance of low viscosity has proved to be the greatest single factor in reducing gas-cutting and the risks of blow-outs, and the saving in barytes consumption has been enormous.

The most general completion method adopted at present is to cement 6⅝-in. casing through the oil-zone and gun-perforate at the selected points. The 6⅝-in casing is run in 8¼-in. or 8½-in. hole, and it is also usual to run 28-lb. pipe opposite all sands that are likely to be gun-perforated later, irrespective of depth.

This string of casing is invariably run with a down-whirler cement shoe and a cement float-collar, or some form of back-pressure valve one joint above the shoe. The use of wire wall-scratchers and other forms of centring device on the casing has not been generally adopted, but various trials of such equipment have been made. Most companies operate their own cementing truck equipped similarly to those of cementing companies in the United States. There is also one privately owned cementing company that operates two units. This company serves several of the smaller operators and wildcat wells, and also obtains a good deal of work from the larger companies during busy periods.

Cement is mixed through a hopper by pumps mounted on the cementing truck, and is pumped down by the drilling pumps. In placing the cement, some operators accurately measure the mud pumped behind the cement from specially installed tanks; others merely rely on the stalling of the pumps as an indication that the plug has reached bottom. A Halliburton measuring line is, however, run on practically all jobs.

The technique of squeeze cementing has proved very effective in Trinidad, and squeeze jobs of various types are carried out to shut off water, either as an initial completion practice or in later repair work. Owing to close proximity of the oil and water sands and the lack of good shale-breaks, it is considered good practice in many instances to carry out a squeeze job on any doubtful section of the hole immediately after the original cement job has set. A. H. N.

47.* **Mechanical Rigs Well Adapted for Hazardous Foreign Service.** W. A. Sawdon. *Petrol. Engr*, Oct. 1941, **13** (1), 90.—A great many wells being drilled in various countries are exploratory wells. Considering the transportation facilities to these wells, diesel engines are probably more widely used than gasoline engines, because diesel fuel is more easily transported and handled. There is a tendency at present to use for foreign operations engines that are convertible from diesel fuel to gas, gasoline, or butane. Butane has not yet been used extensively because it can seldom be obtained, but the advantage of changing over to gas or gasoline is obvious when the engine is put into service where such fuels are economically available. When a wildcat well drilled with diesel power becomes a discovery well, the equipment is then available for development purposes with whatever fuel is most economical. Mechanical rigs originally exported for development work in proved fields will obviously be powered by engines using the most economical fuel.

Air transportation is briefly mentioned. The mobility of a modern mechanical rig is its most outstanding feature.

There is an inclination to rate a power-rig by the horse-power of the prime movers. Although this may be considered as an index, it must be remembered that the transmission and brake capacity are definite factors in determining the capacity of the rig. Circulation requirements will vary under different conditions, and different pump capacity must be provided. Reserve power may sometimes be necessary for draw-works performance as well as for driving additional pumps. Additional engines can be installed to meet certain operating conditions at one location, and may advisably be removed during the drilling of another well. By proper compounding, the power of any one, of all, or of any number of the engines may be applied to the draw-works or to the pumps, and the power thus distributed to meet the requirements at any period during drilling operations. A. H. N.

48.* **Methods of Conducting Marine Operations on Lake Maracaibo.** W. A. Sawdon. *Petrol. Engr*, Oct. 1941, **13** (1), 101.—The derricks at all the Lago's lake locations are supported by reinforced-concrete piles (either square, solid, or round caisson type), but the derrick floor, with a cantilever extension for the engine, is very much like that of an ordinary land location. All other facilities for drilling the well, however, are provided by barges. As soon as a well has been rigged up, a drilling barge is moved alongside and anchored with its forward end parallel to the side of the floor of the derrick. At the stern of this barge are four 300-lb. boilers which supply steam to the engine through a hose connection between barge and derrick. The mud-pumps, generally two 15¼ by 7¾ by 20, which are on the barge directly ahead of the boilers, are also supplied with steam from the barge boilers.

The forward part of the barge has two decks, the upper serving as a pipe-rack, from the front of which a ramp extends to the derrick floor. Below the upper deck are storage compartments for drilling mud and fuel oil. Around the lower deck is a steel settling ditch, through which the returns pass after coming from the well through a large-diameter hose. A shaker screen is so arranged that it can be put in or taken out of the mud-stream as desired.

A mud-barge equipped with two 250-brl. tanks is used to replenish the mud supply on the drilling barge when needed, and for carrying back to land any spent mud containing oil or any other foreign matter that might contaminate the lake-waters.

This mud-barge and a similar barge carrying fuel oil is towed to the drilling operations by a power-boat or launch. A separate barge (35 ft. by 80 ft.) is used for cementing operations. It has a sheet-iron house to provide protection for the cement while the barge is being towed to a job. A belt conveyor runs through the centre of the house and transfers cement in bags to a platform. A knife in the platform automatically slits the paper bags, and the loose cement is deposited in a mixing hopper that feeds the 12 by 6½ by 14 slurry pumps. Three of the slurry pumps are mounted on the barge, any two of which can be compounded to discharge at a pressure of 1100 lb./sq. in.

In operation the cement barge is moored alongside the drilling barge, and the steam-head on the drilling barge is connected by a flexible hose connection to the steam-header on the cementing barge. The discharge header on the slurry pumps is connected by a drilling hose to the well. After the slurry has been pumped into the casing, it is displaced with drilling mud by the mud-pumps on the drilling barge.

Other barges and equipment are described. A. H. N.

40.* Drilling and Production Methods in Western Canada. H. E. Denton. *Petrol. Engr*, Oct. 1941, **13** (1), 140.—An historical sketch is given. Drilling, since the discovery of crude oil in Turner Valley, has been almost exclusively with heavy-duty steam rotary rigs with 136-ft. derricks. Water supply is very abundant from three rivers originating in the mountains. This water is excellent boiler-water, and consequently a minimum treating expense is necessary. High-pressure gas is also plentiful from the separators of producing wells.

An average time of 6 months is required to drill and complete one of these wells, and during that time an average of 200 rock-bits are used to the lime and thirty-five to forty while drilling the lime. The usual tool-joint replacement per well is 33⅓% and, with proper care, drill-pipe, before abandonment, can be expected to drill 40,000 ft. of hole. Beyond that point the limit of fatigue is exceeded, resulting in an excessive number of twist-offs. This short life of drill-pipe and tool-joints is explained by the extremely hard formations from the surface down and the large number of trips per well. Because of the large number of trips, the hoist and other corresponding moving parts are subjected to much wear.

The casing programme consists in normal cases of 600–700 ft. of 13⅜-in. surface casing, cemented solid to the surface, and a string of 7-in. O.D., 26-lb. production casing set on top of the limestone cemented to approximately 3000 ft. from bottom up. In the drilling of the 9-in. hole into which the 7-in. casing is set, little trouble is experienced with regard to casing, sloughing, etc.

The mud problem is quite simple. The only mud added to the circulating system is that at the time of beginning the hole and setting surface casing. From then on the bit makes its own required mud. No weighting material is needed because of the depth at the time the producing horizon is penetrated.

Many completed wells produce no oil, nor will they build up any gas pressure until given a series of acid treatments. A total of 10,000–20,000 gals. of acid is usually used in a series of acid treatments; in some extreme cases more than 40,000 gals. have been used. The average well, after final acidization, usually produces 500–900 brls./day as flush production and is capable of maintaining a steady daily rate of 30–40% of this initial flow. Most wells, however, do produce a little oil before acidization, but a very small flow is expected, perhaps 100–200 brl. The percentage of completions that result in dry holes is extremely low, although many wells are relatively small.

Following the final acidization most wells flow very steadily and with a gas–oil ratio of about 1000 cu. ft./brl. This gas–oil ratio gradually increases proportionately with the total oil withdrawn. The rate of withdrawal also has a pronounced effect on gas–oil ratio.

The wells are tubed to bottom with either 2½-in. or 3-in. upset tubing, and the well control heads, for the most part, are made up of the consolidated-type equipment with flanged connections, and are usually 4000-lb. test. The tank-farms are equipped with high-pressure separators, enough storage to provide gauging facilities, gas-meters for measuring the tail-gas, a "dog-house" in which the meters are installed and records kept, and a boiler for heating purposes. The oil is heated only to 70° or 80° F. before delivery to the pipe-line. As there is no water in the oil, the only heat required is that necessary to meet pipe-line specifications. The object is to maintain

constant temperature on the line all the year round. A very satisfactory oil gathering system is available. A. H. N.

50.* Methods of Plugging Wells with Cement in Iraq and Syria. M. W. Cook. *Petrol. Engr*, Oct. 1941, **13** (1), 160.—The Kirkuk field lies approximately 75 miles south-east of the city of Mosul and 150 miles north of Baghdad. In this field there are three domes on the crest of the anticline, two of which, the Baba Gurgur and Avanah, produce oil; the third, Khurmala, produces gas. The two oil-domes are considered to be continuous, and form a structure approximately 60 miles long and 4 miles wide. The wells can produce as much as 130,000 brl./day flowing through 6-in., 4-in., or 3-in. flow-lines with a hydrostatic pressure of approximately 200 lb./sq. in. The depths of the wells range from 1700 to 2700 ft. As the entire field is controlled by one company, operations have been designed to produce the oil as efficiently and economically as possible. Although wells to determine the limits of the field have been drilled, production has been confined to a small area on the crest of the main dome, and the other wells have been used as observation and control wells. The few wells produced were fully adequate to provide maximum capacity of the pipe-lines to the Mediterranean coast. How much oil is being produced and transported through the pipe-lines at present is not known.

A few months before the war began it was ordered that all but two wells in the Mosul area be cemented. None of the wells in this area was equipped with tubing; the wells were produced through the casing. Another advantage to the cementing operations was that the lime formation took fluid at 50–1000 lb./sq. in., and so eliminated the use of a portable derrick and the running of tubing to displace the cement-plug. Consequently, a plug-holder cement-head was built to hold two top plugs. One plug was released and followed by a batch of cement slurry consisting of about 10 sacks. The top plug was then released on top of the cement and displaced with water to within 50 ft. of the bottom of the casing. The cement was allowed to set for 3 days, after which the master gates were opened to test the plug. If it was found to be holding, the well was bailed by hand to a point 10 ft. below the master gate. Here another top cement-plug was pushed down to the top of the fluid, and was followed with enough cement to fill the casing to the master gate. When this operation was finished, the master gate was removed and a solid iron plate bolted to the casing flange.

Arab crews, under the supervision of Roumanian and Polish drillers, followed behind the cement crew and filled in the rig cellars to obliterate all traces of an oil-well. Flying over these locations some months later, the majority of the sixty-one wells thus treated were not discernible from the air. A. H. N.

51.* Current Methods of Driving Concrete Piles at Lake Maracaibo. W. A. Sawdon. *Petrol. Engr*, Oct. 1941, **13** (1), 165.—As drilling operations in this area are done in the lake-pile, supports are used. Until a little more than two years ago all piles employed for this purpose were of the solid, square, reinforced-concrete type; but as development of the lake fields continued wells have been located farther from the lake shore and in deeper water. The solid concrete piles have been used successfully in depths as great as 60 ft., the piles being as long as 133 ft. The true lake bottom, which is hard shale, is covered with a mud silt that varies in thickness from practically nothing to more than 100 ft., and in order to overcome the conditions found in deep water a tubular or caisson type of pile was developed. To date, this type of pile has been used for derrick foundations only, as other structures on the lake have not been constructed in the deeper water.

All piles are pre-cast at a plant at La Salina situated in the northern part of the lake fields. The solid, reinforced piles are made in three sizes: 16 in., 20 in., and 24 in., the 16 in. for lengths up to 70 ft., the 20 in. for lengths of 70–100 ft., and the 24 in. for lengths greater than 100 ft. The piles are transported to the location on barges, and are there driven by a pile-driver. For derrick foundations there are three piles—two plumb and one batter—at each corner. The number and arrangement of piles for other structures depend on the size and loads to be supported.

The pile-driver crane has a capacity of 59 tons on a 30° angle. The leads can swing 90°, thus providing for the driving of batter piles front, back, or on either side. Only one move of the driver barge is necessary in driving an entire derrick foundation. The piles are picked up from the carrying barge by a crane on the driver barge.

Operations are performed with steam supplied by boilers on the barge, which are fired with fuel oil.

After the piles are driven, they are stripped to elevation and capped with reinforced concrete. On this cap a 24-ft.-square steel base is set and grouted-in and the derrick erected.

Derricks in deep water built on caisson-type foundations have one of these tubular-type piles at each corner. The hollow piles are 60 in. in diameter and are cast in 15-ft. sections. Each section consists of a steel inner lining encased in a 5-in. sheath of concrete strengthened by spiral steel reinforcement. The steel inner liner is made up of two half-cylinders welded together longitudinally to form a cylinder, which is centred in a cylindrical concreting form. The annulus between the steel cylinder and the form is poured with concrete after the spiral reinforcement has been set in place, the section being on end and the concrete subjected to vibration during pouring to ensure complete and smooth placement. After removing the form and curing the concrete, the number of sections required to provide a desired length of pile are welded together at the steel and grouted at the concrete. At the bottom of each pile thus made is a concrete shoe 5 ft. in length and conical in shape, that forms a point to facilitate passage through the mud and penetration into the harder formation at the bottom of the lake. A. H. N.

52. Patents on Drilling. L. C. Beers. U.S.P. 2,255,754, 16.9.41. Appl. 8.3.39. Multiple record electrologging of wells.

R. A. Lillich. U.S.P. 2,256,119, 16.9.41. Appl. 21.10.38. Back-pressure valve in combination with a drill-stem.

T. J. Crawford. U.S.P. 2,256,455, 16.9.41. Appl. 30.3.40. Oil-well casing of a thin-walled type.

E. J. Turner. U.S.P. 2,257,080, 23.9.41. Appl. 10.10.39. Drill-pipe cleaner for cleaning the inside of drill-stems.

A. Boynton. U.S.P. 2,257,101, 30.9.41. Appl. 30.6.39. Threadless drill-pipe.

P. E. Harth. U.S.P. 2,257,114, 30.9.41. Appl. 22.8.36. Application of drilling fluids containing surface-treated iron particles resistant to oxidation.

C. A. Lundeen. U.S.P. 2,257,120, 30.9.41. Appl. 3.10.39. Well-pipe support in an elevator.

S. Evans and R. S. Grant. U.S.P. 2,257,335, 30.9.41. Appl. 5.5.40. Tool-joint welding.

G. Knutson. U.S.P. 2,257,418, 30.9.41. Appl. 31.3.38. Detachable bit rock-drill.

W. R. Coleman. U.S.P. 2,257,733, 7.10.41. Appl. 29.10.38. Apparatus for drilling terrestrial bores.

D. Scaramucci. U.S.P. 2,257,765, 7.10.41. Appl. 30.9.39. Cementing device for well-casings.

L. C. Chamberlain. U.S.P. 2,258,001, 7.10.41. Appl. 23.12.38. Subterranean boring into calcareous formation by means of hydrochloric acid.

A. C. Catland. U.S.P. 2,258,352, 7.10.41. Appl. 27.11.39. Core-drill for use on tubular rotary wells drilling strings.

S. Evans. U.S.P. 2,258,751, 14.10.41. Appl. 27.4.40. Method of making welded tool-joints.

J. S. Morgan. U.S.P. 2,258,785, 14.10.41. Appl. 29.4.39. Draw-works.

J. C. Fortune. U.S.P. 2,258,887, 14.10.41. Appl. 5.2.40. Stuffing-box.

R. O. Laird. U.S.P. 2,258,934, 14.10.41. Appl. 7.11.40. Oil-well rack device in combination with a derrick.

N. D. Allen. U.S.P. 2,259,191, 14.10.41. Appl. 27.9.39. Stem for core-drills.

A. R. Hopkins. U.S.P. 2,259,206, 14.10.41. Appl. 20.2.39. Cathead for drilling apparatus.

A. J. Hodge. U.S.P. 2,259,223, 14.10.41. Appl. 15.2.39. Rotary machine.

A. J. Hodge. U.S.P. 2,259,224, 14.10.41. Appl. 22.1.40. Drill-stem drive device.

A. L. Stone. U.S.P. 2,259,232, 14.10.41. Appl. 17.8.38. Well pipe-joint.

D. G. Hefley and J. G. Standt. U.S.P. 2,259,419, 14.10.41. Appl. 23.10.37. Well drilling with a drilling fluid.

W. P. Holland. U.S.P. 2,259,564, 21.10.41. Appl. 2.7.40. Means and method of removing casing from wells.

R. A. Perkins. U.S.P. 2,259,775, 21.10.41. Appl. 3.2.41. Cement bag cutting means in combination with a pair of tables.

B. F. McNamee and F. Rieber. U.S.P. 2,259,904, 21.10.41. Appl. 17.1.38. Method and apparatus for lagging bore-holes.

J. E. Hoffoss. U.S.P. 2,260,320, 28.10.41. Appl. 23.11.40. Coring apparatus with a latching mechanism for a wire-line core-barrel.

W. L. Childs. U.S.P. 2,260,366, 28.10.41. Appl. 12.3.40. Reamer for rotary well-drilling.

F. L. Scott. U.S.P. 2,260,487, 28.10.41. Appl. 27.2.40. Fluid deflector for well-drills to deflect fluids away from the bearings of cutters.

F. B. Williams. U.S.P. 2,260,499, 28.10.41. Appl. 16.5.38. Application of mud-laden or drilling fluid.

L. Dillon. U.S.P. 2,260,562, 28.10.41. Appl. 13.12.37. Process and apparatus for core sample orientation.

H. W. Cardwell. U.S.P. 2,260,604, 28.10.41. Appl. 27.10.38. Well-drilling machine which is portable and comprises a tractor.

I. S. Salnikov. U.S.P. 2,261,292, 4.11.41. Appl. 25.7.39. Method for completing oil-wells.

L. A. Layne. U.S.P. 2,261,441, 4.11.41. Appl. 4.2.39. Cementing machine with a concrete mixer and conveyor, including a centrifugal pump.

A. B. Lore. U.S.P. 2,261,501, 4.11.41. Appl. 3.3.41. Bearing destroyer for rock-bit cutters.

W. W. Gipson. U.S.P. 2,261,546, 4.11.41. Appl. 8.12.39. Shrouded drill-bit.

S. Robichaux and G. J. Barrett. U.S.P. 2,261,564, 4.11.41. Appl. 9.5.40. Method of removing stuck-pipe from wells.

H. W. Russell and H. A. H. Pray. U.S.P. 2,261,566, 4.11.41. Appl. 31.5.40. Protector ring or coupling for pipe joints.

W. M. Schultz. U.S.P. 2,261,570, 4.11.41. Appl. 11.7.39. Cothead.

D. Hering. U.S.P. 2,262,934, 18.11.41. Appl. 10.6.39. Well-surveying method for determining the path of a bore-hole.

R. W. Stuart. U.S.P. 2,263,108, 18.11.41. Appl. 16.7.40. Logging wells during drilling using ultra-violet light on the mud stream to detect oil which may be present.

E. J. Protin. U.S.P. 2,263,223, 18.11.41. Appl. 12.3.40. Thread protector.

G. A. Nichols. U.S.P. 2,263,364, 18.11.41. Appl. 23.10.39. Cementing bracket in the form of a well-casing elevator.

A. H. N.

Production.

53.* Voluntary Crude-Oil Curtailment in California Effective. A. H. Bell. *Oil Gas J.*, 30.10.41, **40** (25), A 46.—Proration problems are discussed and the "uniform formula" is given as the engineer's answer to these problems. It recognizes the marginal well; it recognizes, too, that a prolific flowing well can bear a greater percentage of curtailment than can a small settled well; and that there is a maximum limit more than which no well should produce.

With the minimum depth allowable, the marginal well is permitted to produce without restriction. The Conservation Committee designates the marginal well as one the potential of which is less than the total exemption provided under the minimum formula for the particular depths, the exemption itself having been developed after consideration of several factors. The most important of these is the average lifting cost, which is relatively high on a per-barrel basis, since all of these wells are pumpers, so that the exemption provides a "living wage" for many wells which would otherwise be forced off production, with the resultant loss of reserves.

The minimum-allotment provision of the uniform formula gives each well not less than 10 brl./day, if it is capable of that amount of production, and, in addition, gives each well an allotment based on depth. The depth minimum now provides for an allotment of 5 brl. for the first 1000 ft. of depth; 5 brl. plus 0·75 brl. for the second 1000 ft.; 5·75 brl. plus 0·75 brl. or 6·50 brl. for the third 1000 ft., and so on. In the actual application of the depth minimum, fractions are discarded and whole numbers are used, a table being constructed so that the wells within a given depth range receive the same minimum. For example, a well at 5583 ft. would receive 37·5 brl./day under the formula, whilst one at 5695 ft. would receive 38·5. The tables give wells between these two depths 38 brl. minimum allotments.

The second step in the formula is commonly known as the sliding-scale-percentage curtailment, and is the curtailment applied to the potential remaining after the minimum allotment is deducted. This curtailment is applied to all intermediate wells, which are defined as those wells falling between marginal and top classifications, on the same principle as that of income taxation—namely, that the percentage of curtailment increases as the production increases, on the theory that prolific wells are best able to bear the burden of curtailment, as wealthy individuals are of taxation. This method is a refinement of the straight percentage method, and avoids the tendency of the latter method to allocate a disproportionate share of the total allotment to flush-wells.

The third step in the uniform formula is the application of the top allowable, which is arbitrarily set by the committee at its monthly meetings, and which has been reduced from 250 brl. per well in June 1939, when the formula went into effect, to 143 brl. in October 1941. This allotment is given to each well capable of earning it under the formula. A. H. N.

54.* Improved Method of Installing Liners at Raisin City Field. T. P. Sanders, *Oil Gas J.*, 30.10.41, **40** (25), A 92.—A new method, developed to meet severe sand conditions, has been evolved after several failures. The patented method used for the final successful completion is unique in that the liner is run on tubing. Following this step, and without removing the tubing, the bottom of the hole is washed out, the well is washed in by circulating fluid or gas around the liner, the packer at the top of the liner is expanded inside the casing shoe, the christmas tree is installed, and the tubing is hung in final position, all without killing the well,

The method is illustrated schematically and described in detail. A. H. N.

55.* New Method of Washing Gravel-Packed Liners in Wilmington Completions. T. P. Sanders, *Oil Gas J.*, 30.10.41, **40** (25), A 95.—Completion methods are described, as these help in understanding the procedure of washing the gravel-packed liners. The washer is made up on the end of the drill-pipe, using $2\frac{7}{8}$-in. flush-joint drill-pipe as a tail on the $3\frac{1}{2}$-in. string, so that the washer can be run to the bottom of the liner. Placement of the swab rubbers on the washer is a matter of choice, but the interval between the opposed rubbers is usually 1 ft. This 1 ft. interval in which the fluid is discharged is placed opposite the lowest perforations of the liner, and the pump at

the surface is started. Circulation is carried on for 1 min. before the drill-pipe is raised to take in a new interval. If the pressure recorded on the gauge at the surface is considered too high, circulation is carried on for a longer period, to see if the differential pressure through the gravel pack can be reduced by thorough washing.

The pipe is raised 6 in. at a time, so that no intervals can be missed. It is, of course, necessary to shut down the pump before attempting to raise the drill-pipe, as otherwise the swab rubbers would adhere to the liner. It has been noted that much less pressure builds up while washing a liner if the walls of the hole have been previously scraped by the formation scratchers. Thus the washer has served to show the effectiveness of an instrument which would otherwise be very difficult to evaluate.

A regular 7¼ by 14 in. slush-pump is generally used for circulation of the fluid, but sometimes a cementing truck is employed for the sake of convenience or because greater pressures are required. In nearly all cases water is used as the circulating medium while washing prepacked liners, although light mud is more likely to be used when the formation scratchers are being applied to the open hole.

After washing of the liner has been completed, it is standard practice to raise the washer well above the top of the liner and replace the water in the casing with mud, which is intended to hold the well under control while the tubing is run and the christmas tree is assembled.

Time required for washing depends on liner length and the depth, but a few examples of actual jobs are as follows: for cleaning 836 ft. of prepacked liner in the Upper Terminal zone, 13½ hr. were required, including running in, washing, and placing the mud-cap in the casing. For cleaning 661 ft. of liner in the Ford zone (total depth 5400 ft.) 12 hr. were required for the job. For cleaning 256 ft. of liner in the Ranger zone, 8½ hr. were required. A. H. N.

56.* Review of Multiple-Zone Production in California. R. F. Cory. *Oil Gas J.*, 6.11.41, **40** (26), 88. *Paper Presented Before American Petroleum Institute.*—When several productive zones are present in a field, the wells should be drilled so that the production from each zone can be controlled without affecting other zones. The differences between zones in pressures, gravity, and value of the oil, gas–oil ratio, edge-water conditions, sand production, and other factors make this desirable.

The conditions necessary to insure the practicability of multiple-zone wells are fairly rare. In general, California practice indicates that separate wells to each zone are to be preferred to multiple-zone wells because of additional recovery and fewer operating difficulties.

The primary reasons for the use of multiple-zone wells, in almost all cases, have been limited space, offset requirements, and increased potentials per well.

In general, multiple-zone wells are recommended: (1) when most of the recovery will be by natural flow (perhaps aided by repressuring), the pumping life short, and the field deep; (2) when the energy of one zone can be used as a natural gas-lift for oil from another zone; (3) when space is limited and the number of wells is restricted; (4) when the establishing of high gas or oil potentials per well is important.

In most cases in which a multiple-zone well is desirable, a two-zone well is to be preferred to a three-zone well. The advantages of a three-zone well over a two-zone well are likely to be more than offset by the difficulties inherent in the more complex installation.

The methods and procedures used to drill, complete, and produce a multiple-zone well must be varied to suit the field and even the location. The following is a brief statement of the chief considerations: a two-zone well is relatively simple; a three-zone well is much more complex, expensive, and troublesome.

The chief problem in drilling a multiple-zone well is the separation of the zones by cement outside the liner. The best method of cementing depends on the special conditions found in the field and well. Recementing is sometimes necessary, but the majority of the cement jobs give no trouble. The production problems are more serious. Packers give trouble by leaking or failing to set. When sand is produced, sand-blasting of tubing and casing will occur. Also, a few feet of packed sand can almost prevent removing a packer.

Repairs are difficult and expensive. In short, although multiple-zone wells may be economically desirable, they are troublesome mechanically.

The production history of multiple-zone wells is given. A. H. N.

57.* Control of Gas–Oil and Water–Oil Ratios by Chemical Treatment. H. T. Kennedy. *Oil Gas J.*, 6.11.41, **40** (26), 92. *Paper Presented Before American Petroleum Institute.* —This paper describes typical chemical treatments for reduction of gas– and water–oil ratios by the plugging of selected portions of the producing formations, and mentions briefly similar treatments applied to cable-tool drilling wells to shut off excessive water. Records of six water-plugging treatments, chosen to represent various successful treating methods, and eleven gas-plugging treatments are included. The latter group consists of all the applications up to the present time of chemical plugging methods to the wells of two major companies in the Goldsmith Pool, Ector County, Texas. Conditions essential for successful application of chemical plugging methods are discussed.

A survey of the present status of chemical formation plugging indicates that these methods have useful and economical application in three distinct fields: first, in treating cable-tool drilling wells to shut off excessive water; second, in treating producing oil- and gas-wells to cut down pumping costs and avoid back pressure on producing formations; and, third, in the lowering of gas–oil ratios in producing formations underlying gas-caps. The Goldsmith pool is the first location where a sufficient number of wells have been treated for gas–oil ratio control to determine the operators' chance of success, and in that field 82% of the wells treated were brought substantially to or below the penalty limit of 5000 cu.ft./brl. A. H. N.

58.* Oil-Well Tests Suggest New Rating Standards. H. E. Dralle and E. H. Lamberger. *Oil Gas J.*, 6.11.41, **40** (26), 98. *Paper Presented Before American Petroleum Institute.* —In oil-well pumping there are many known variables which directly affect the design and application of equipment used in the economical production of oil. To ascertain the individual effects of these variables on the performance and ratings of oil-well equipment and to augment the many theoretical considerations already given to them, Phillips Petroleum Co., Sargent Engineering Corp., and Westinghouse Electric & Manufacturing Co. jointly made a series of more than 200 tests, extending over a continuous period of six months.

The actual tests included independent variation of the speed, stroke length, counterweighting working-barrel size, tubing diameter, and type of prime mover. Under these varying conditions, oscillographic film was used to show fourteen simultaneous records of instantaneous loads and displacements occurring during a pumping cycle.

Instruments were placed in the incoming power line, in the low-speed gear shaft, on the pitman, at two different points on the walking beam, on the polished rod, and at two different points in the sucker-rod string. Correlated with these were polished-rod dynagraph charts and bottom-hole dynamometer records.

The paper covers that part of these tests which suggests the development of new formulas for predetermining, from a known set of well conditions: (1) peak polished-rod load; (2) pump plunger stroke; (3) peak crankshaft torque.

These new formulas, with supporting data, are given, and results from their use compared with those obtained from existing formulas and with actual test results. Suggestions are also made that other perplexing problems incident to oil-well pumping may be solved conveniently with these same basic and fundamental test data.

It is concluded that: (1) stroke length on a well using either beam or rotary counterweights to give practically equal power peaks on the up- and down-stroke is not appreciably affected by the type of prime mover; (2) peak polished-rod loads, under the same conditions of counterbalancing, are also unaffected to any practical degree by the type of prime mover; (3) peak torques on the crankshaft do vary with the prime mover, being greatest with the normal-slip motor. There was no observable difference in peak torque between the high-slip motor and the engine, unquestionably because both have speed-torque curves that result in appreciable speed drop with load increase and because of flywheel effect in the mechanical system. A. H. N.

59.* Leak Resistance of Casing Joints in Tension. P. D. Thomas and A. W. Bartok. *Oil Gas J.*, 6.11.41, **40** (26), 147. *Paper Presented Before American Petroleum Institute.* —This paper consists essentially of two parts: (*a*) tension-leak tests; (*b*) photo-elastic study of stresses in casing joints.

Leakage tests were made on casing joints subjected simultaneously to internal

pressure and increasing tensile load. The loading under pressure was continued until full leakage was obtained. Pressure was then removed and the joint pulled to destruction.

Results indicated that the standard eight-pitch round-thread casing joint had leak resistance in tension beyond that required in service. Yield strength of the joint was apparently the controlling factor. Long-thread joints had a higher leak resistance than short-thread joints, although it was questionable if this extra tightness was of practical value. Thread lengths intermediate to A.P.I. long and short threads appeared advisable. Thread make-up was a critical factor, three threads pulling being the optimum. Differential in taper lowered leak resistance, but this tendency was overcome by proper make-up.

Photo-elastic study developed fundamental information concerning stresses in casing joints, supplementing and explaining the results of tension-leak tests. The usefulness of the photo-elastic method in analyzing stresses in casing joints was pointed out.

The similarity of tension and make-up stresses in the last-engaged thread areas was confirmed by the fact that distortion of threads in make-up was in the same direction, although less than that found in pulled-out joints. With tension and make-up stresses being additive, the possibility of preloading and overloading a joint by make-up was demonstrated. In the tension-leak tests, leak efficiency fell off with make-ups over three threads. The lowered leak resistance was explained by the combined make-up and tension stresses preloading the casing specimens sufficiently to cause yielding at reduced loads. Consequently, lower leak points and joint efficiencies developed. The early yielding took place at the points of highest stress concentration.

The essential difference between tension and make-up stresses lay in the point of concentration—tension stresses concentrating under the open root, make-up stresses under the closed root of the last engaged thread. With this difference present, the maximum stresses produced by each were not directly additive, but the similar stresses combined with each other directly according to the stresses that existed at identical points. A. H. N.

60.* Critical Review of Methods for the Determination of the Porosity, Permeability, and Saturation of Core Samples. M. D. Taylor. *Oil Gas J.*, 20.11.41, **40** (28), 40.—In view of the published methods of core analysis used for the determination of the porosity, permeability, and saturation of oil-field core samples, it was become increasingly evident that the particular method to be adopted depends on the type of samples to be analyzed, the speed with which an individual result is required, the number of samples to be handled, and the degree of accuracy needed. The methods of analysis which have been found most useful are briefly described and the conditions for which they are most adaptable are stated.

For porosity determination without crushing, the sample is extracted and dried, the bulk volume is determined either by the displacement of a liquid which does not penetrate the sample or by saturating the sample and displacing a liquid with the saturated sample, and either the grain volume is measured by the displacement of a gas or a liquid, or the pore volume is measured by determining the amount of liquid necessary to saturate the sample. An alternative method of obtaining the grain volume which may be used for approximate work is simply to divide the dry weight of the sample by 2·68, since the density of the rock-grains will seldom deviate more than 3–5% from this figure. Six methods of accomplishing the same results but with different degrees of accuracies and speeds are described.

Porosity measurements which involve crushing the samples are briefly discussed.

Permeability measurement with dry air is discussed, note being taken of Klinkenberg's findings regarding the variation of permeability with mean pressure.

The methods for the determination of liquid saturation usually consist of analyzing the sample for water and measuring the total loss of weight on extraction and drying. The quantity of oil present is then calculated by subtracting the weight of water found from the total loss in weight. The determination of water by distillation, by the critical solution temperature method, using ethyl or *iso*propyl alcohol to extract the water and then determining the temperature equal volumes of alcohol solution and kerosine become totally soluble, and finally by the titration method, is discussed in some detail. A. H. N.

61.* Air–Gas Proves Good Stripper Area Recovery Agent. F. R. Cozzens. *Oil Wkly*, 17.11.41, **103** (11), 47.—More than 70% of the eastern stripper-field producers are located in areas where gas must be piped in from outside sources, the cost of this and various other factors making its use prohibitive as a recovery measure. Many producers in such areas have been experimenting during the past five years with air and gas combined. In summarizing results thus obtained, ample proof is found that when an air–gas ratio not lower than 3 to 1 (three parts air, one part gas) is maintained, the producer gets full benefits of air pressure plus a reconditioning of the sandy body resulting from the use of gas. Cost is 40–60% less than when gas is used alone, which places the method within the economic range of small operators.

The air–gas method differs but slightly from regular air-pressuring, except that gas in required amounts is fed through a jet to the intake of an air compressor, and that traps are placed on the producing wells so that the air–gas mixture can be saved for re-use. On small leases, regular oil-storage tanks are used for air–gas storage. There is no set rule which determines the amount of gas fed to the air under pressure. The richer the mixture, the more speedy is its effect on the sand-body; but the cost of gas and its limitations must be reckoned with, so that the average producer generally adheres to the 3 to 1 ratio. A. H. N.

62.* Treating Water for Disposal in Surface Channels. C. H. Rankin. *Petrol. Engr*, Oct. 1941, **13** (1), 27–28.—When the fluid comes from the wells in the proportion of about 1 brl. of oil to 10 brl. of water, it separates readily when heated, except for a residue of about 1%, which remains suspended in the water as an emulsion. This emulsion can be broken down with the Treto-lite compound recommended for the purpose, but it must be allowed to settle in large pits before the separation is complete. The oil can then be skimmed from the pits and the water discharged through surface channels.

Almost every known method has been tried in this field to obtain complete removal of the last traces of oil from the water. At one time the water was run into large open pits having porous bottoms, and attempts were made to skim off clean oil. At another time the water from the settling pits was run through a series of hay-tanks in an effort to skim off the oil. These and many other methods that were attempted proved unsuccessful.

It has been suggested that the chemical should be added before the oil enters the heater—a practice commonly followed in many other treating systems. This suggested practice has been tried, but without success. Emulsion was carried over into the stock-tanks.

Treating costs in this field have run as high as 5 cents/brl., although at present they are less than half that amount. The Wellington field now produces 200 brl. of oil daily, with 1800 brl. of water from eleven wells that average 4500 ft. in depth. All wells are equipped with standard rig fronts and pump 24 hr./day. A. H. N.

63.* Effect of Velocity on the Mixing of Liquids in Porous Media. V. V. Hendrix and R. L. Huntington. *Petrol Engr*, Oct. 1941, **13** (1), 48.—In this investigation five different sizes of porous media were studied. Two miscible liquids were used simulating gases under high pressures. Two sizes of tubes, a ½-in. and a 1-in. tube, served as packed reservoirs. The porous medium in the tube was saturated with carbon tetrachloride, which was then displaced by normal hexane, injected into the bottom of the vertical tube. The amount of mixing was determined for different rates of flow. It was found that a Reynolds' number near a value of 1 (in consistent units) gives the least mixing, which is a desirable condition for such operations.

The sand was saturated with carbon tetrachloride as it was being packed into the tube. After the tube was packed it was inverted and attached by means of a union to a pressure bomb containing normal hexane. A constant-pressure head was maintained on the hexane in the bomb by placing natural gas pressure on the upper surface of the hexane. The pressure on the gas main was 30 lb./sq. in., allowing considerable freedom in the rate of producing the mixture. After the packed tube was in place, the gas pressure-valve was opened; then the valve separating the pressure bomb and the packed tube was opened. The needle valve at the top end of the packed tube was then adjusted until the desired rate was obtained. This process amounts essentially

to washing out the carbon tetrachloride with the hexane. Consecutive samples of produced liquid were taken during each run.

The produced liquid was analyzed first by means of a pycnometer and a chainomatic balance. Some of the densities were taken with a Westphal balance. Sample sizes depended on the amount of carbon tetrachloride in place. It was impractical to continue the test until all carbon tetrachloride had been recovered. The tests were terminated when the volume of hexane injected was equal to twice the original volume of the carbon tetrachloride in place. As there was no shrinkage of liquids on mixing, the amount of hexane injected was volumetrically equal to the amount of liquids produced. A. H. N.

64.* **Centralized Control of Closed Gathering System in Arabian Field.** D. Nix. *Petrol. Engr*, Oct. 1941, **13** (1), 93.—One of the most interesting features of operations in Arabia is the oil-gathering system used in the Damman field. Briefly, the system consists of: (1) individual flow-lines from each well to (2) a central gas-trap setting, from which oil flows to (3) a stabilizer, and is discharged into (4) field-tanks. The system is then given in some detail.

The author believes that the system described is unusual in that it allows complete control of the flow-rates of all wells in the field from one location and a closed system from well to field-tanks that includes gas separation, individual well-gauging, stabilization, and H_2S removal. It might be pointed out that the system is not considered an experimental one; it has been functioning satisfactorily for about two years.

A. H. N.

65.* **Drilling and Production Activity in Foreign Fields.** W. A. Sawdon. *Petrol. Engr*, Oct. 1941, **13** (1), 150–152.—Of the oil-producing areas of the world outside the North American Continent it appears that the greatest increase in activity in the near future will be in South America. There is still a lag due to the loss of markets caused by the war in Europe, but there now appears to be a growing demand for South American petroleum products for British use. An indication of this prospect is the recent increase in orders for oil equipment and the probability of larger orders to provide stores for long operating periods. In some instances ordering for 1942 is already in progress.

There is also a likelihood of increased activity in the East Indies, Burma, and possibly India, as those areas will have to maintain production even though they may not greatly increase the amount of oil produced. Expansion of petroleum developments in the Near East will be delayed until after the war, but it can be assumed that when hostilities are over plans held in abeyance will be put into effect. In the Near East to-day, however, several strings of drilling tools are running. Western Europe and Russia seem to be out of the picture at present so far as exploratory work or expansion of development operations is concerned.

A brief review is given of activities in South America, Argentina, Colombia, Ecuador, Venezuela, Trinidad, the Near East, Europe and Russia, India and Burma, and the Far East. A. H. N.

66. **Patents on Production.** F. N. Osmun. U.S.P. 2,255,857, 16.9.41. Appl. 4.10.38. Hydraulic-power transmitter control.

H. R. Downs. U.S.P. 2,255,918, 16.9.41. Appl. 16.2.40. Well-pump comprising a gas-driven motor.

L. Hegy. U.S.P. 2,255,924, 16.9.41. Appl. 6.4.40. Pneumatic displacement pump.

H. E. Drake. U.S.P. 2,256,552, 23.9.41. Appl. 19.3.40. Retrievable formation tester adapted to be mounted in drill-pipe.

C. E. Moseley. U.S.P. 2,256,567, 23.9.41. Appl. 2.2.40. Well-pump of the reciprocating type.

G. W. Taylor. U.S.P. 2,256,599, 23.9.41. Appl. 4.12.39. Well-pump operating apparatus.

R. W. Bier. U.S.P. 2,256,605, 23.9.41. Appl. 3.6.39. Counterbalancing apparatus for well-pumps.

L. R. Thrasher. U.S.P. 2,256,659, 23.9.41. Appl. 25.6.40. Deep well-pump motor of the submersible type.

C. S. Crickmer and J. J. Lane. U.S.P. 2,256,704, 23.9.41. Appl. 17.10.38. Flow device for gas-lift tubings.

W. H. Brenot. U.S.P. 2,257,225, 30.9.41. Appl. 3.9.40. Sub-casing-head take-off for wells.

H. C. Marsh and W. M. Quilter. U.S.P. 2,257,269, 30.9.41. Appl. 7.10.40. Tubing plug.

I. J. McCullough. U.S.P. 2,257,270, 30.9.41. Appl. 14.11.39. Gun perforator for well-casings.

I. J. McCullough. U.S.P. 2,257,271, 30.9.41. Appl. 10.2.40. Perforating gun with serial firing means.

J. F. Maloney. U.S.P. 2,257,344, 30.9.41. Appl. 11.1.40. Screen-pipe with gravel between two perforated pipes.

C. A. Combs. U.S.P. 2,257,523, 30.9.41. Appl. 14.1.41. Well-control device for wells having a casing with tubings arranged therein.

N. F. Brown. U.S.P. 2,257,784, 7.10.41. Appl. 26.8.38. Plug for use in wells to force material through a pipe.

R. B. Barnes. U.S.P. 2,257,997, 7.10.41. Appl. 27.11.40. Breaking petroleum emulsions of the water-in-oil type.

L. C. Chamberlain. U.S.P. 2,258,000, 7.10.41. Appl. 15.3.37. Treatment of wells producing mineral fluid to reduce the flow of water.

T. G. Myers. U.S.P. 2,258,064, 7.10.41. Appl. 27.5.38. Sealed electric motor adapted to be submerged into a well liquid.

F. E. Scheider. U.S.P. 2,258,103, 7.10.41. Appl. 9.7.38. Well-pumping apparatus with hydraulic engine and sucker-rods.

C. R. Neilon. U.S.P. 2,258,190, 7.10.41. Appl. 4.9.40. Unitary packing and gland structure for casing-heads and the like.

R. P. Miller. U.S.P. 2,258,299, 7.10.41. Appl. 15.8.38. Automatic pumping in wells fitted with tubing strings.

J. F. Kendrick. U.S.P. 2,258,614, 14.10.41. Appl. 28.2.38. Method of treating and producing oil-water wells.

J. F. Kendrick. U.S.P. 2,258,615, 14.10.41. Appl. 28.2.38. Apparatus for the treatment and producing of oil-water wells.

J. F. Kendrick. U.S.P. 2,258,616, 14.10.41. Appl. 8.7.39. Treatment and producing of oil-wells.

R. H. Carr, K. A. Covell, and C. F. Terrell, Jr. U.S.P. 2,259,019, 14.10.41. Appl. 7.6.30. Apparatus for pumping oil-wells.

W. H. Wineman. U.S.P. 2,259,020, 14.10.41. Appl. 9.12.38. Apparatus for pumping wells.

W. H. Wineman. U.S.P. 2,259,021, 14.10.41. Appl. 9.12.38. Apparatus for pumping oil-wells.

K. E. Moehrl. U.S.P. 2,259,262, 14.10.41. Appl. 12.11.40. Means for well-cleaning through annular screen to surrounding strata.

P. G. Shelley. U.S.P. 2,259,428, 14.10.41. Appl. 23.4.40. Treatment of wells to remove paraffin and the like.

D. M. Simmons. U.S.P. 2,259,429, 14.10.41. Appl. 1.8.39. Method of treating wells with a fluid treating agent.

L. T. Monson and W. W. Anderson. U.S.P. 2,259,704, 21.10.41. Appl. 12.5.41. Process for resolving petroleum emulsions.

F. A. Bent and A. G. Loomis. U.S.P. 2,259,875, 21.10.41. Appl. 9.9.36. Method fo treating oil- and gas-wells.

M. P. Burke. U.S.P. 2,259,949, 21.10.41. Appl. 21.4.38. Fluid-lift apparatus for wells.

C. F. Bonnet. U.S.P. 2,259,995, 21.10.41. Appl. 30.1.41. Breaking petroleum emulsions of the water-in-oil type.

W. F. Tebbetts, Jr. U.S.P. 2,260,127, 21.10.41. Appl. 11.3.40. Deep-well pumping mechanism.

D. O. Sproule. U.S.P. 2,260,347, 28.10.41. Appl. 22.7.37. Echo-sounding apparatus with a device for measuring and indicating the time periods between the emission of sound-pulses and the reception of the echo pulses.

F. D. Stanley. U.S.P. 2,260,544, 28.10.41. Appl. 20.10.39. Polish-rod clamp.

D. E. Humphrey. U.S.P. 2,260,669, 28.10.41. Appl. 8.8.40. Well-pump in combination with a tubing string which can be rotated from the surface.

D. E. Humphrey. U.S.P. 2,260,671, 28.10.41. Appl. 4.10.40. Well-pump in combination with a tubing string which can be rotated from the surface.

C. J. Wolff. U.S.P. 2,260,696, 28.10.41. Appl. 5.8.38. Hydraulic pump for wells operated by fluid pressure.

H. Richter. U.S.P. 2,260,789, 28.10.41. Appl. 29.7.39. Outflow regulator for petroleum separators.

T. A. Rial. U.S.P. 2,260,916, 28.10.41. Appl. 5.12.40. Electric heating device for oil- and gas-wells.

R. W. Erwin. U.S.P. 2,261,057, 28.10.41. Appl. 15.7.40. Emulsion treating and brine injection system for oil-wells.

R. W. Erwin. U.S.P. 2,261,100, 28.10.41. Appl. 25.7.41. Brine injection method for oil-wells.

R. W. Erwin. U.S.P. 2,261,101, 28.10.41. Appl. 25.7.41. Emulsion treating apparatus for the closed type.

A. Boynton. U.S.P. 2,261,135, 4.11.41. Appl. 8.12.39. Differential stage lift-flow device for wells.

A. N. Porter. U.S.P. 2,261,180, 4.11.41. Appl. 6.9.38. Rocker bearing for an under-pull jack.

L. A. Layne. U.S.P. 2,261,440, 4.11.41. Appl. 4.2.39. Well-head control.

R. L. Harter. U.S.P. 2,261,468, 4.11.41. Appl. 24.6.40. Friction-activated sleeve-valve for foot-valve pumps.

R. L. Harter. U.S.P. 2,261,469, 4.11.41. Appl. 26.8.40. Sleeve-type foot-valve for pumps.

N. W. Buckner. U.S.P. 2,261,752, 4.11.41. Appl. 24.1.40. Fluid pressure motor.

C. A. Ricon. U.S.P. 2,261,859, 4.11.41. Appl. 9.10.39. Oil and gas production gun perforator.

A. Boynton. U.S.P. 2,262,750, 18.11.41. Appl. 28.11.38. Flow intermitter for controlling wells.

A. Boynton. U.S.P. 2,262,751, 18.11.41. Appl. 31.1.39. Pneumatic piston pump, differential type.

A. Boynton. U.S.P. 2,262,752, 18.11.41. Appl. 31.1.39. Pneumatic piston pump, differential type.

C. C. Cole. U.S.P. 2,262,925, 18.11.41. Appl. 7.8.39. Projectile and barrel for gun-type perforators.

J. E. Hall. U.S.P. 2,263,086, 18.11.41. Appl. 15.5.40. Fluid motor.

C. N. Scott. U.S.P. 2,263,144, 18.11.41. Appl. 18.4.39. Pump for deep wells having two plungers.

R. E. Franklin. U.S.P. 2,263,267, 18.11.41. Appl. 22.6.40. Tubing-joint breaker for connecting and disconnecting oil-well tubing coupling.

A. L. Armentrout. U.S.P. 2,263,412, 18.11.41. Appl. 30.9.40. Method and means of perforating pipe. A. H. N.

Transport and Storage.

67.* New Developments in Painting of Tanks and Other Structural Steel. A. T. Saunders. *Oil Gas J.*, 1941, **40** (17), 44.—The American national defence programme has resulted in the virtual disappearance of aluminium paints from civilian use in the U.S.A.

Since no pigment has been found which possesses powers of resisting water permeation equal to those of aluminium flake, new paints for tanks, steelwork, etc., are being formulated to make use of anti-corrosive priming coats. These primers frequently make use of the known protective properties of the chromate and phosphate ions. The continued slight solubility in water of zinc chromate, and the immunizing effect of the solution on the metal surface, make this pigment of great value as a component of such primers. A content of 15–25% of the pigment is recommended.

Recently developed light-coloured finishing coats are generally based on very opaque rutile types of TiO_2, with or without ZnO, in an oil vehicle reinforced with high-mol. wt. synthetic resin. C. G. G.

68.* Cathodic Protection of Montana Power Company's Pipe-Lines. C. R. Davis. *Oil Gas J.*, 2.10.41, **40** (21), 45.—At the time of construction of this Company's pipe-line system, electrolysis was controlled by insulation, the approved method of the time. Three years later alvanic action, etc., had caused faults where there were imperfections in the coatings, and in 1936 a programme to place the entire system under cathodic protection was initiated. After a complete survey of pipe to ground potentials, the first rectifying unit was installed in 1937, and by the end of 1940, 90% of the transmission system, 80% of the distribution system and the storage tanks, well-casings, etc., of the producing company were under cathodic protection. The various systems are described in detail, four types of units being employed—viz., copper oxide rectifiers, motor generators, wind generators, and gas-engine-drive generators, of which the first has proved most dependable.

A photographic recording voltmeter has been developed for use with the wind generators, and the instrument is described. Results given by this and by other test instruments indicate that the better the pipe coating the longer the effect of polarization, and that the latter will increase the effectiveness of a wind generator by at least 20%.

A variety of ground-bed installations are in use, and are described, whilst the article concludes with a discussion of operating costs. J. C.

Crude Petroleum.

69.* **Practical Suggestions for Improving Quality of Crude Oil.** F. R. Cozzens. *Petrol. Engr*, 1931, **12** (13), 98.—Various difficulties which may arise through the use of unsuitable equipment or through faulty handling of crude oil under field storage conditions are very briefly discussed.

Methods used for the reduction of evaporation, and for the removal of troublesome sludge and colloidal matter before pumping to the lines, are sketched in outline.

C. G. G.

Gas.

70.* **City Gas.** W. L. Jones and F. E. Vandaveer. *Industr. Engng Chem.*, 1941, **33** (7), 852.—The causes and effects of the smoke problem in urban communities are reviewed and the economics of the supply of smokeless fuel discussed. Data are given on the properties and combustion of gaseous fuels. Special reference is made to the part gas has taken in the smoke-abatement problem in the St. Louis metropolitan area.

J. W. H.

Cracking.

71.* **Unusual Properties of Houdry Cracked Products Revealed.** H. P. Broom. *Oil Gas J.*, 27.3.41, **39** (46), 164.—Houdry cracked gasolines from commercial units using natural clay catalysts have octane numbers (A.S.T.M. or motor method) of 77–80, but the newly developed synthetic catalysts produce gasolines of 78–81 O.N. The ability of Houdry gasolines to meet modern engine requirements is indicated by their research method octane numbers, which vary from 86 to 92, the road octanes by the Union town method having been shown to be nearer the research method than the motor method. Curves showing the influence of speed on the motor-knocking tendencies of various fuels of similar octane number indicates that the Houdry gasoline provides more than the maximum power requirement throughout the entire range, whereas a leaded straight-run gasoline falls off badly at low speeds. Houdry gasolines also have a flat octane distillation curve, so that in a multi-cylinder engine perfect distribution of the vaporized and unvaporized fractions is not required to eliminate knock. Lead susceptibilities are good, the sulphur content being low and paraffin content high, 1 c.c. of TEL per gallon increasing the O.N. (A.S.T.M.) from 77·4–80·9 to 82·7–86·2, and 3 c.c. of TEL to 84·9–90·1. The blending value with straight-run and cracked fuels of about 70 O.N. is relatively high and is almost arithmetical. Doctor-sweetened Houdry gasoline has an exceptionally low stability (10-hr. induction period in the oxygen bomb). In view of the high octane number of the heavy ends, it is not necessary to reduce the end-point, particularly as the product has ample front-end volatility.

The catalytic gas-oil or recycle stock can be thermally cracked, blended with heavy fuels, cut to specification furnace oils, or used as low-speed diesel-engine fuels. On cracking, the gas-oil gives similar yields to fresh stocks of similar gravity distillation characteristics (*e.g.*, a 73·5% yield of gasoline of 74·3 O.N. by Houdry, followed by thermal cracking, as compared with a 65·9% yield of 71 O.N. gasoline by thermal cracking alone). A further point is the catalytic reduction in sulphur of the charging stock. The dry gas produced over a 10-lb. Reid gasoline may contain more than 50% of C 4 fractions, 80–85% of the butane being *iso*butane, useful for alkylation. Butylenes vary from 10% of the C 4 cut when reforming or cracking light oils to more than 50% when cracking reduced crudes or residues. The cracked tar may be viscosity broken, coked, blended with thermally cracked tars to reduce viscosity, reduced to asphalt and binders, or burnt as fuel.

C. L. G.

72.* **Use of Stress-Rupture Data in Inspecting Cracking-Still Tubes.** C. L. Clark. *Oil Gas J.*, 2.10.41, **40** (21), 39.—As a basis for design, and for the inspection of cracking-still tubes after each operating cycle, stress-rupture tests are said to be the most useful laboratory procedure.

Stresses are greater than in the creep test and specimens are carried to actual fracture, loads being adjusted so that fracture occurs after widely differing times.

Stress *versus* rupture time is plotted, and with logarithmic co-ordinates straight lines result. With the standard 5 CrMo-type steel a discontinuity occurs in the straight line at 1200° F. and higher, due to surface scaling. These relationships give stresses corresponding to definite fracture times at each temperature considered, and by plotting stress *versus* temperature, and by extrapolation, a series of constant-fracture time curves results. The use of these curves in inspecting cracking-still tubes is demonstrated by an actual example showing how it is possible to determine the extent to which the tube-metal temperature can rise before the operating cycle must be discontinued. J. C.

73. Patent on Cracking. Standard Oil Development Co. E.P. 540,408, 16.10.41. Appl. 31.1.40. Method of cracking hydrocarbon oils by admixing therewith an absorbent solid catalyst and passing the mixture through a cracking zone. Thereafter the catalyst is separated from the cracked products and the latter fractionated to obtain a normally gaseous fraction, a motor-fuel distillate fraction, and a higher-boiling fraction. The normally gaseous fraction is further fractionated to obtain a light fraction consisting chiefly of hydrogen, methane, and ethane, and a heavier fraction consisting principally of hydrocarbons having 3–4 carbon atoms. The lighter or heavier fraction is recycled to the cracking zone. H. B. M.

Polymerization and Alkylation.

74. Patents on Polymerization and Alkylation. Anglo-Iranian Oil Co. E.P. 540,449, 17.10.41. Appl. 10.3.41. Production of saturated hydrocarbons by the alkylation of *iso*butane or *iso*pentane by condensation with one or more lower olefins in the presence of concentrated sulphuric acid. After alkylation the alkylate is washed with fresh concentrated sulphuric acid under agitation for the removal of sulphur. Finally the alkylated product is subjected to distillation.

Texaco Development Corporation. E.P. 540,459, 17.10.41. Appl. 19.4.40. Method of alkylating hydrocarbons by reacting an olefin with an *iso*paraffin hydrocarbon in the presence of a liquid catalyst consisting of a boron trifluoride–water complex containing 21–29% by weight of water.

K. Korpi and A. R. Goldsby. U.S.P. 2,260,943, 28.10.41. Appl. 25.6.37. Manufacture of normally liquid hydrocarbons boiling within the gasoline range by reacting low-boiling polymers with an *iso*paraffin selected from the group consisting of *iso*butane and *iso*pentane in the presence of concentrated sulphuric-acid catalyst. By maintaining a substantial excess of the *iso*paraffin in the reacting mixture, alkylation of the *iso*paraffin is effected and a substantially saturated liquid reaction product is produced.

A. R. Goldsby and K. Korpi. U.S.P. 2,260,944, 28.10.41. Appl. 29.7.39. Alkylation of a normally liquid cracked naphtha fraction to increase its anti-knock value. The cracked naphtha fraction is treated with added *iso*butane in the presence of concentrated sulphuric acid under alkylating conditions. In this way *iso*butane reacts with the normally liquid olefins originally present in the cracked naphtha fraction to produce alkylation products.

K. Korpi and A. R. Goldsby. U.S.P. 2,260,945, 28.10.41. Appl. 18.6.37. Manufacture of normally liquid hydrocarbons boiling within the gasoline range by reacting low-boiling olefins with a low-boiling *iso*paraffin in the presence of concentrated sulphuric acid catalyst while maintaining alkylating conditions. H. B. M.

Synthetic Products.

75.* Reaction Products of Olefins with Sulphuric Acid. R. F. Robey. *Industr. Engng Chem.*, 1941, **33** (8), 1076.—The reaction products of *n*-butene with sulphuric acid are shown to be alkyl sulphuric acid (30–40%), and the remainder is considered to be in the form of the alcoxonium ion. In the light of the observations, a criticism of the reported values of the heat of reaction between butene and sulphuric acid is given. J. W. H.

Refining and Refinery Plant.

76.* Nomograph for Selecting Electrical Heaters. J. J. Sorrell. *Industr. Engng Chem.*, 1941, **33** (7), 961.—A nomograph is given enabling the selection of a suitable heater for petroleum products in a continuous system to be made easily from a knowledge of the working temperature range, density, and flow-rate. J. W. H.

77.* Use of a Third Component to Improve the Fractional Distillation of Binary Liquid Mixtures. D. B. Keyes. *Industr. Engng Chem.*, 1941, **33** (8), 1019.—The basic requirements for the effective use of a third component in the fractional separation of an azeotropic binary mixture are reviewed. Examples are also given of the addition of a third component to form an azeotrope with one of the components of the binary mixture to facilitate the separation. J. W. H.

78.* Alignment Chart for Optimum Amount of Water in Heat Exchangers. R. D. Douglass and D. P. Adams. *Industr. Engng Chem.*, 1941, **33** (8), 1082.—The construction of the chart is described and the method of estimating the optimum amount of cooling water is illustrated by an example. J. W. H.

79.* Early Plant for the Preparation of Toluene from Petroleum. J. B. Terry and C. K. Parker. *Nat. Petrol. News*, 23.7.41, **33** (30), R.234.—The authors describe, in reminiscent vein, the early difficulties in the preparation, in 1915, of toluene by a pyrolytic cracking process. Compared with modern practice the plant was crude, but in view of the absence of background experience, speciality materials, and recording instruments the results obtained were highly commendable. In the final plant twelve retorts, arranged in pairs on a common base, consisted of 18-in.-diameter cast-steel tubing containing a nickel oxide catalyst and maintained by external heating at 700° C. Oil was sprayed in under slight vacuum for 35 min., air being passed for the remaining 25 min. in each hour for the purpose of removing carbon deposits. The gases were discharged through a series of "tar-pots" to a pressure condenser. The crude distillate was fractionated according to current coal-tar refining practice, the residue after the removal of naphthalene being used as a paint-base or as fuel. H. G.

80.* Mercaptan Removal By Extraction with Caustic Soda and Methanol. Anon. *Nat. Petrol. News*, 1.10.41, **33** (40), R.316.—H_2S-free gasoline is fed to the base of a packed column. Methanol is introduced in the middle of the column and aqueous NaOH at the top. The NaOH–methanol solution is drawn off from the bottom and passed to a stripper for the recovery of the methanol. The caustic is regenerated. Almost complete mercaptan removal is claimed. Complete economic and operating data are not yet available, but the process is said to be very promising. H. G.

81.* Refineries in North America. D. H. Stormont. *Oil Gas J.*, 27.3.41, **39** (4), 54, 167, 189.—A brief survey of growth of refinery capacity in U.S. and Canada is given with a table of the capacity, number, and type of plants in operation and shut down in each State. The personnel of refineries and details of the crude oil and cracking capacity and type of refinery of each of the refineries in the U.S., Canada, and Mexico is also given. C. L. G.

82.* Chemistry in Petroleum Refining. L. N. Leum. *Oil Gas J.*, 27.3.41, **39** (46), 85.—A brief review is presented of the systems of nomenclature of hydrocarbons, including general names, names in the substitution system, and names on the Geneva system. The fundamental chemistry of various new processes is briefly discussed by means of equations based on single hydrocarbons. C. L. G.

83.* Turner Valley Natural Gas and Crude Oils—a Refinery Evaluation. D. Read and G. Egloff. *Oil Gas J.*, 27.3.41, **39** (46), 142.—Detailed analyses are given of Turner Valley natural gas, the natural gasoline derived from it, the crude oil and products obtained from it by laboratory distillation, and the products obtained by cracking

the topped and reduced crude in a Dubbs pilot plant. The natural gas yields 0·35 gal. of 20-lb. Reid gasoline per 1000 cu. ft. It contains 0·63–0·74% of *iso*butane, 0·99–1·09% of butane, and 0·29–0·36% of *iso*pentane. It is estimated that 75,500,000 gal. per year of butanes are available from the natural gas and 45,500,000 gal. per year could be produced from cracking operations. The butanes could be processed to yield high-octane gasoline by (1) pyrolysis and non-selective polymerization, (2) catalytic dehydrogenation followed by selective polymerization and hydrogenation, (3) fractionation with *n*-butanes for catalytic dehydrogenation and *iso*butanes alkylated by the preceding olefines, and (4) polymerization of olefines in cracked gases from various cracking, reforming, etc., operations. From method (2) 5000 brl./day of 95–100 octane aviation fuel could be produced.

Two samples of Turner Valley crude have been analysed, the lighter yielding 21·7% of 250° E.Pt. gasoline of 68 O.N., or 47·5% of 400° E.Pt. gasoline of 53 O.N., and the heavier crude very slightly less gasoline. The topped crude has a pour-point of 50° F. and a viscosity S.U. at 100° F. of 52·9 sec., and after removal of 26·8% of gas-oil the reduced crude has a pour-point of 80° F. and a viscosity of S.U. at 100° F. of 144 sec. On cracking the crude oil, topped crude, and reduced crude, yields were obtained of 82%, 63·1%, and 59·8% of gasoline of O.N. 64, 68·5, and 70, respectively. The cracked residues meet the S.C. 2 grade road-oil specifications of the Asphalt Institute, as well as the No. 6 fuel-oil specification. A cracked side-cut oil is suitable for use in low-speed diesel engines (cetane number 35), or could be distilled to produce a tractor distillate of 49 O.N. Catalytic polymerization of cracking plant and stabilizer gases, alkylation of the butylenes with *iso*butane, and polymerization of the residual gas from alkylation added to alkylate bottoms would yield 4·3%, 5·0%, and 2·4% of gasoline, respectively, on the crude. Doctor and copper-sweetened straight-run and cracked gasolines show a satisfactory lead response, 1, 2, and 3 c.c. of TEL/gal. increasing the O.N. from 63 to 70, 73·5, and 76, respectively. Satisfactory storage stability and gum content are obtained by inhibiting, but dyeing is required owing to its poor colour, unless additional refining, such as clay treatment, is provided. C. L. G.

84.* Laboratory-Controlled Reflux Distillation Apparatus. R. W. Harkness and R. E. Bland. *Oil Gas J.*, 27.3.41, **39** (46), 148.—A description is given of a controlled reflux distillation apparatus suitable for laboratory control of full-scale or pilot-plant yields of gasoline from cracked or reformed distillates. The apparatus has a capacity of 3 or 5 litres, and is constructed of interchangeable glass parts, with the exception of the reflux condenser of coiled copper tubing in an insulated metal bath. The method of heating preferred is a glass fabric mantle in which heating coils are embedded, surrounding the glass distillation flask. The fractionating column is 1½ in. in diameter and 18 in. long, and is surrounded by a vacuum jacket, silvered on the inside. The tower packing consists of $\frac{1}{16}$-in. stainless steel helices of 0·016-in.-diameter wire. The automatic reflux regulator is electro-magnetically controlled, and can be adjusted by an electric timing device for different reflux ratios. The reflux condenser over the column is cooled by water, the product condenser by refrigerated ethylene glycol–water at 0° F., and the vapour condenser by dry ice–spirit at − 60° F. A complete distillation takes 4 hr. (50% yield). The degree of separation obtained with the laboratory distillation is about the same as that in the plant. Tables of properties and distillation curves of representative distillation runs are included.
C. L. G.

85.* Finish 20 Tons of Wax Daily Without Using Sweat Pans. D. A. Young. *Oil Gas J.*, 1941, **40** (11), 34.—A descriptive account of the Sinclair Refining Co's new solvent-dewaxing and wax-finishing plant at Houston.

The dewaxing solvent consists of M.E.K.–benzene–toluene (45 : 40 : 15). The flow-sheet given is of normal type. Cooling is obtained by direct expansion of NH_3. The filters employed are of the rotary-drum continuous type.

The wax-cake is passed through a two-stage stripping process to recover the adhering solvent, the resulting slack wax then being given a second solvent treatment in lieu of the customary sweating process. In the second solvent treatment the solvent–wax ratio is high (15 : 1 by vol.).

After filtration, washing on the filter, and removal of solvent, the resulting " crude

scale" wax is given one of two further treatments, according to whether "finished semi-refined" or "finished fully-refined" wax is ultimately required.

For production of semi-refined wax, the crude scale is given acid and soda treatments, followed by water washing, deodorizing with superheated steam under vacuum in a small bubble-tower, and earth percolation.

For production of fully-refined wax, the scale is given a third solvent extraction before the finishing treatment, which is the same as that described for the semi-refined grade. The great bulk of the wax is processed to 130–132° F.

In all stages of the process where solvent vapour is present the gaseous phase is diluted with CO_2 to prevent the formation of explosive mixtures with air.

The article is liberally illustrated with photographs, and the full flow-sheet is shown. C. G. G.

88.* Continental Adds Four Types of Solvent Units to Separate Dewax Lube Oil Stocks. W. T. Ziegenhain. *Oil Gas J.*, 7.8.41, **40** (13), 30.—Four different types of solvent units have been placed in full-scale operation at the Ponca City, Okla., plant of the Continental Oil Co. These include two for treating the oil—furfural and Duosol plants—and two for dewaxing—M.E.K. and Bari-Sol plants.

The furfural plant receives daily about 1200 brl. of light-wax distillate, S.U. viscosity of 75–80 sec. at 100° F. The raffinate is freed of solvent, sent to the M.E.K. plant for dewaxing, and then re-run to make a 180 viscosity motor-oil base. The asphaltic portion is cracked after removal of solvent.

The Duosol unit receives daily about 1600 brl. of heavy vacuum-distilled lube bottoms, which is contacted with liquid propane and "selecto" at 300 lb./sq. in. The oil raffinate is dewaxed in the M.E.K. plant, while the asphaltic fractions are cracked.

The refinery also produces about 550 brl. daily of a heavy overhead cut of oil of 500 viscosity at 100° F. This is segregated, and may be processed by either of the extraction units, being subsequently dewaxed and reduced to produce an S.A.E. 30-grade motor oil.

The Bari-Sol plant is used primarily to dewax residue oils in the manufacture of very heavy pale-lube stocks. One of the principal products of this process is a zero cold-test oil of 160 viscosity at 210° F. The feed oil, viscosity 350 at 210° F., is mixed with ethylene dichloride and benzene and chilled to — 20° F., when the wax separates.

An important adjunct to these processes is the use of additives. In the highest-quality oils methyl dichlor-stearate is used as an oiliness dope, and a small quantity of "thialkene" is added. This is a sulphonated olein made at the refinery, and it is claimed that its use improves the oxidation characteristics of the oil. D. L. S.

87.* Liquefaction and Degasification of Lighter Hydrocarbons. F. W. Laverty and W. C. Edmister. *Oil Gas J.*, 1941, **40** (17), 35.—Up to the present, very little attention has been paid to the thermodynamic properties of the hydrocarbons usually handled by industrial liquefaction plants. The authors point out that for efficiency in the design and operation of such plants, accurate knowledge of the entropies and enthalpies of the hydrocarbons is required, in addition to the details of vapour pressures, boiling points, dew points, and critical points.

A thermodynamic survey of methane, propane, butane, propylene, and three mixtures of light hydrocarbons was carried out, using the reduced thermodynamic data afforded by Edmister's method, together with experimental calorimetric and vapour-pressure or phase-diagram data. The results were incorporated in Mollier diagrams, showing enthalpy *versus* pressure (on log. scale) with temperature, entropy, and volume parameters.

These diagrams furnish a great deal of useful data for the design and power provision of liquefaction and refrigeration plants generally. Extended examples of their applications are given.

A general description of the natural-gas liquefaction and storage plant now being operated by the E. Ohio Gas Co. at Cleveland is given.

The article is illustrated with the relevant Mollier diagrams. A photograph and diagrams of the plants discussed are also included. C. G. G.

88.* New Refinery Processes. T. B. Leech. *Oil Gas J.*, 2.10.41, **40** (21), 40.—Refinery processes developed during the last few years are concisely surveyed.

Two new vapour-phase developments are described. In the first, topped crude, distillate, or naphtha at high temperature and at pressures of 200 lb./sq. in. is submitted to pyrolysis and to further reaction with some uncracked charge. A large yield of high-octane gasoline is given, and, in certain conditions, this may contain 6–8% of toluene. The second process, distinguished by higher pressure, lower temperature, and the omission of the second reaction, operates on naphtha and produces a high-octane fuel, which may be fractionated to yield an aviation cut.

Training-grade aviation fuels may be produced by debutanizing natural gasoline, removing the pentane, and blending back the depentanized natural gasoline with *iso*pentane, obtained by fractionation of the pentane cut. The yield may be leaded to 90 octane, and the remainder of the natural gasoline can be blended into motor fuel or can be alkylated or polymerized.

By alkylation, high-octane products are obtained from *iso*paraffins and olefins. A simple type of reaction is the combination of butene and *iso*butane to *iso*-octane by the sulphuric-acid catalyst process. At higher temperatures unsaturates may be polymerized into octylene, which is an excellent blending fuel, or may be hydrogenated to *iso*-octane. An outstanding alkylation process is the formation of neohexane from ethylene and *iso*butane. Neohexane has an octane rating of 94 and can be leaded to 115, and the reaction is of particular importance from the standpoint of U.S.A. resources, since it utilizes a lighter gas than is usually considered feasible for commercial alkylation. If it is economically desirable, butane may be isomerized, thus increasing the raw stock of *iso*paraffins available for alkylation.

n-Butane and *iso*butane may be converted into *n*-butene and *iso*butene by dehydrogenation at temperatures of 975–1025° F., at pressures of 15–25 lb., using chromium oxide or alumina as a catalyst. The yield may be polymerized using a solid phosphoric-acid or a sulphuric-acid process to give high-octane fuel or octylene, which latter may be hydrogenated at 75° F. and at 5–50 lb. pressure, over a nickel oxide catalyst, to *iso*-octane.

Catalytic-cracking plants in general use, operating on crude residual oil, distillate or naphtha, yielding gasoline of 77–81 octane rating, have a daily capacity of some 250,000 brl. A second process of this type operates catalytically on naphtha and hydrogen and gives a yield of 80% when the octane rating is raised by 30–40. The product contains 40–50% of aromatics and 15–20% of toluene. A notable advance in this branch of refining is the use of a movable catalyst, which is fed into the vapour, removed from the reacted products, rejuvenated, and returned to the system.

These processes are important in the U.S.A. national defence programme, and the article concludes with a statistical discussion of available refining capacity in relation to present emergency needs, to normal consumption and exports, and to the probable demands of the near future. J. C.

89.* High-Pressure Absorption of Natural Gasoline. E. J. Squire. *Oil Gas J.*, 2.10.41, **40** (21), **48.**—Natural-gas wastage is already much reduced in quantity through controlled production, gas injection, depletion of reserves, and increased demand. Further conservation measures are still, however, necessary, and the present condensed and non-technical article deals briefly with the conversion of the Ventura plant of the Shell Oil Co. from low-pressure to high-pressure absorption. This plant, built in 1926, operates at 30 lb., but associated companies, who take 80% of the gas, compress it to 250–400 lb. pressure. The gas-fuel available will be diminished, depending on the quantity of butanes and propane required as liquid products. J. C.

90.* Gasoline Plant Employs Two Fractionators in Series. J. C. Albright. *Petrol. Engr*, 1941, **12** (13), 27.—Many plants which are producing more than one grade of natural gasoline use only one column, and consequently batch processing is required.

A new plant near Cunningham, Kansas, is now producing two grades of natural gasoline by means of a continuous process in which two columns are employed in series.

Low-pressure and high-pressure gas, from older and newer producing wells, respectively, are fed to two sets of absorbers in parallel operating at 50 lb./sq. in. and 600

lb./sq. in., respectively. The absorption oil from the high-pressure absorbers is pumped directly into one of the low-pressure absorber columns, with two attendant advantages. Duplication of "fat-oil" pumps is eliminated, and venting the high-pressure oil into the low-pressure column serves to remove unwanted ethane and other low-boiling constituents without the necessity for recompressing and recovering desirable fractions. Raw gasoline of R.V.P. 55–60 lb./sq. in. is recovered from the wash oil, and is then separated by means of a two-stage pressure fractionation into natural gasoline of R.V.P. 12 lb./sq. in. and "Liquefied Petroleum Gases" (L.P.G.) of R.V.P. 80 lb./sq. in. Working details of the distillation system are given for these products. C. G. G.

91.* Laboratory Tests of Cathodic Protection of Steel in Various Corrosive Solutions. W. R. Hill. *Petrol. Engr*, 1941, **12** (13), 51.—A laboratory investigation was carried out to determine the significance in cathodic protection of steel of each of the factors: (*a*) concentration of electrolyte; (*b*) ionic constituents of electrolyte; (*c*) p_H value; (*d*) time of contact; (*e*) current density and metal-solution potential relationships.

It was found that variations of (*a*), (*b*), and (*d*) had little or no effect on the minimum current density required to ensure complete protection. On the other hand, solutions of low p_H value appear to require augmented current density as compared with neutral solutions. In general, complete protection is attained at a current density of about 10 mA./sq. ft., but 0·001*N*-H_2SO_4 ($p_H = 4$) showed appreciable corrosive action even at 35 mA./sq. ft. Protective conditions are usually, but not invariably, attended by some polarization.

Full details of apparatus and technique are given, and the experimental results are shown in graphical form. C. G. G.

92.* Rates of Flow and Heat Loss in Refinery Steam Piping. R. G. Lovell. *Petrol. Engr*, 1941, **12** (13), 59.—Charts from the Crane Co.'s publication, "Engineering Data on Flow of Fluids in Pipes," are reproduced, and their application to steam-flow and heat-loss problems is illustrated by means of examples.

It is pointed out that the rate of discharge of steam from a high-pressure system to a system at lower pressure increases as the lower pressure is reduced down to 58% of the higher pressure; thereafter the rate does not change with increasing pressure difference. The use of this effect for controlling rates of steam supply is suggested.

The following subjects are discussed: rates of flow of steam through valves, piping, and orifices; heat losses from bare steam piping. C. G. G.

93.* Review of the Fundamentals of Hydraulics. R. W. Machen. *Petrol. Engr*, 1941, **12** (13), 126.—An elementary exposition of the quantitative aspects of fluid-flow through pipes and orifices, and over full-width, end-contracted, and triangular weirs.

Tables of discharge coefficients are given for full-width and end-contracted weirs discharging water. C. G. G.

94.* Reabsorber in Gasoline Plant Controls Pressure or Entire Distillation System. Anon. *Petrol. Engr*, 1941, **12** (13), 142.—A brief description, with photographs, of the new natural gasoline plant built by the Del Valle Gasoline Co., near Saugus, Cal.

A novel feature of the plant is that, with the exception of the main absorber, all vessels and vent-tanks throughout the distillation and condensate system are pressure controlled by means of a single back-pressure controller on the reabsorber.

C. G. G.

95. Patents on Refining and Refinery Plant. Standard Oil Co. E.P. 539,385, 9.9.41. Appl. 4.10.39. Process for conversion of relatively heavy hydrocarbon oils into lower-boiling hydrocarbons by subjecting the vaporized oils to the action of a catalyst consisting of silica gel, the internal pore surface of which is coated with a thin layer of thorium compound.

Standard Oil Co. E.P. 539,844, 25.9.41. Appl. 4.9.40. Method of recovering oil adhering to the spent catalyst obtained from a hydrocarbon conversion process. The catalyst is treated with hot normally gaseous hydrocarbons at a temperature the same

as or slightly below that at which the conversion process was carried out. The treatment can be applied to spent catalysts from catalytic cracking, reforming, dehydrogenation, aromatization, alkylation, isomerization, polymerization, etc.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 539,867, 26.9.41. Appl. 4.4.40. Process for the removal of weakly acid-reacting substances from water-insoluble neutral or weakly basic organic liquids with the aid of an aqueous solution of a strong base. Treatment with the base is carried out in the presence of a salt of a non-aromatic dicarboxylic acid having from 5 to 11 carbon atoms in the molecule, and in which the carboxyl radicals are separated by at least two carbon atoms.

Standard Oil Development Co. E.P. 540,287, 13.10.41. Appl. 15.11.39. Catalytic treatment of hydrocarbon oils. The oil is contacted with a solid catalyst which becomes fouled with carbonaceous matter during the process. Accordingly the operation is interrupted from time to time and the catalyst regenerated. The throughput of the oil and the temperature of the reaction in the cracking zone are kept constant, and the length of the cracking operation is progressively reduced as the activity of the regenerated catalyst becomes depreciated.

S. R. Merley. U.S.P. 2,257,914, 7.10.41. Appl. 7.12.39. Process for the neutralization of sulphuric-acid-treated mineral oils and removal of oil-soluble soaps without the use of caustic alkali solution. The acid-treated oil is further treated with an excess of a solution of normal alkali metal sulphite.

W. W. Johnstone. U.S.P. 2,258,249, 7.10.41. Appl. 27.4.39. Method of sweetening hydrocarbon distillates containing mercaptans by treating with sodium plumbite solution and a quantity of elementary sulphur in excess of that required to convert the mercaptans into lead mercaptides. Afterwards the distillate is treated with a solution of an alkali metal hydroxide containing a relatively small amount of a low-boiling mercaptan. This solution is used in sufficient amount to remove the excess sulphur from the distillate, which is then recovered without further plumbite treatment.

T. F. McCormick. U.S.P. 2,258,512, 7.10.41. Appl. 6.7.38. Method of purifying a cracked petroleum hydrocarbon oil by intimately mixing and reacting therewith a straight-run sulphuric-acid sludge to form a mixture of partially purified oil and cracked acid sludge. Afterwards the purified oil is separated from the cracked acid sludge. H. B. M.

Metering.

96.* New Apparatus for Calibrating Gasoline Displacement Meters. E. W. Jacobson. *Nat. Petrol. News*, 6.8.41, **33** (32), R.254.—It is stated that a meter must always be calibrated with the liquid on which it will be used. In the apparatus described this liquid, gasoline or burning oil, is confined over water and passed by hydrostatic pressure through the meter into an accurate measuring device. Adequate precautions to eliminate errors due to evaporation, temperature change, and air entrainment are taken. H. G.

Chemistry and Physics of Petroleum.

97. Polymerization of Olefins. IV. Nonenes from the Dehydration and Copolymerization of *tert.*-Butyl and *tert.*-Amyl Alcohols. F. C. Whitmore and L. W. Mixon. *J. Amer. chem. Soc.*, 1941, **61**, 1460–1462.—Dehydration of an equimolar mixture of the alcohols with 65% sulphuric acid at 80° C. gave a 17% yield of nonenes. Satisfactory separation of the isomeric nonenes could not be obtained by repeated fractionation through a column equivalent to twenty-three theoretical plates; but it was effected by ozonolysis to 2 : 3 : 4 : 4-tetramethyl-1-pentene, 50%; 2 : 3 : 4 : 4-tetramethyl-2-pentene, 10%; 3 : 5 : 5-trimethyl-2-hexene, 23%; 3 : 5 : 5-trimethyl-3-hexene, 5%; and 2 : 4 : 4-trimethyl-2-hexene, 10%. The mechanism of the reaction is discussed. The yields indicate that 88% of the nonenes are formed by the addition of a *tert.*-butyl fragment to an amylene or its equivalent, as compared with 12% formed by the addition of a *tert.*-amyl fragment to *iso*butylene. R. D. S.

98. Catalytic Dehydrogenation of Hydroaromatic Compounds with Benzene. H. Adkins, L. M. Richards, and J. W. Davis. *J. Amer. chem. Soc.*, 1941, **63**, 1320–1325.—A method has been developed for catalytic dehydrogenation in the liquid phase in a

closed system. Such a reaction is reversible without the presence of a hydrogen acceptor or oxidizing agent, and it was found that benzene, which is readily available, stable against polymerization, highly unsaturated, and reacts irreversibly with hydrogen under these conditions, was excellent for the purpose. Although benzene reacts with hydrogen to give *cyclo*hexane, the latter does not suffer dehydrogenation to any appreciable extent in these reactions. Nickel catalysts were employed chiefly. Nickel on chromium oxide was found to be the most active for the dehydrogenation of those saturated hydrocarbons which are particularly resistant to reaction. Supported on kieselguhr or alumina, however, it was better employed for the dehydrogenation of substituted *cyclo*hexanols, as the tendency for condensation was not so great. Platinum was sometimes more active than nickel at lower temperatures, but gave lower yields of phenols. The process consisted in heating the hydroaromatic compound at 300–350° C. in the liquid phase under nitrogen in the presence of benzene and catalyst. Results are given for twenty-eight hydrocarbons, alcohols, ketones, and ethers containing a completely or partly saturated benzene, naphthalene, or phenathrene nucleus. R. D. S.

99. Nitrogen Compounds in Petroleum Distillates. XXI. Isolation and Synthesis of 2 : 3 : 4-Trimethyl-8-*i*-Propylquinoline. L. M. Schenck and J. R. Bailey. *J. Amer. chem. Soc.*, 1941, **63**, 1364–1365).—This material is one of six bases occurring in California kero base of b.pt. 320–330° C. and n_D^{20} 1·5698. Its boiling point is 327° C. The structure was determined, as usual, by chromic acid oxidation to the known 2 : 3 : 4-trimethylquinoline-8-carboxylic acid, and was confirmed by synthesis from methylacetylacetone and *o*-cumidine. R. D. S.

100. Nitrogen Compounds in Petroleum Distillates. XXII. Isolation and Synthesis of 2 : 3-Dimethyl-4 : 8-Diethylquinoline (I) and 2 : 3-Dimethyl-4-Ethyl-8-*n*-Propylquinoline (II). L. M. Schenck and J. R. Bailey. *J. Amer. chem. Soc.*, 1941, **63**, 1365–1367.—Isolation of bases (I) and (II) complete the segregation of the six bases present in the 320–330° C. fraction of the kero base from California petroleum mentioned in the preceding abstract. An admixture of the two was precipitated in acetone–ether solution as nitrates which were converted into picrates. Base II was separated by precipitation from I as acid sulphite. Degradation and synthesis were employed to confirm the structures. R. D. S.

101. Hexabenzylethane. S. A. Hill, W. C. Nelson, R. L. Dunnell, and L. S. Moody. *J. Amer. chem. Soc.*, 1941, **63**, 1367–1368.—The authors have prepared 2 : 2 : 3 : 3-tetrabenzyl-1 : 6-diphenylbutane (hexabenzylethane) by treating tribenzylmethyl bromide in dry ether, and in dry benzene, with sodium, with mercury, and with zinc. The best yield was given by heating with zinc to 50° C. for 48 hrs. in dry benzene. 2-Benzyl-1 : 3-diphenylpropene appeared as an oil, which was decanted from the solid hexabenzylethane. The latter was characterized by nitration to hexanitrohexabenzylethane. R. D. S.

102. III. Two-Component Gel Catalysts Containing Chromium Oxide for the Aromatization of *n*-Heptane. H. Fehrer and H. S. Taylor. *J. Amer. chem. Soc.*, 1941, **63**, 1385–1386.—The dehydrogenation–cyclization of *n*-heptane has been studied in the presence of gel catalysts containing, in addition to chromium oxide, (*a*) the dehydrogenating metals, copper, nickel, and palladium; (*b*) the dehydrogenating metal oxides of manganese, zinc, and molybdenum; (*c*) oxides such as silica, zirconia, and stannic oxide. The results have been compared with those obtained on standard chromium–oxide gel catalysts published previously (*J. Amer. chem. Soc.*, 1941, **63**, 1129–1131; *J. Inst. Petrol.*, **27**, 1941, Abstr. No. 1297).

Of class (*a*), palladium–chromium oxide yielded only that quantity of gas expected from the oxide content. The hydrogen content of the gas was increased, but the conversion to aromatics was below the standard yield. Nickel gave cracking. Copper gave rates higher than those deduced from the oxide content, lower than those with an equal quantity of standard gel. The gas produced was higher in hydrogen content than standard, and the aromatic content of the liquid lower. The catalysts con-

taining the hydrogenating oxides favoured low olefin content with a given production of aromatics. Incorporation of silica does not materially increase gel stability, but produces greater availability of the chromium oxide surface. Owing to their slower rate of poisoning, catalysts containing zirconia and stannic oxide were superior to the standard gel. They are sensitive to the revivification procedure and lose activity. Pure zirconia has dehydrogenating-cyclizing activity towards paraffins at 475° C.
R. D. S.

103. IV. Mechanism of Reaction and of Poisoning in the Dehydroaromatization of *n*-Heptane. H. S. Taylor and H. Fehrer. *J. Amer. chem. Soc.*, 1941, **63**, 1387–1392.—Data are presented on the comparative rates of reaction of *n*-heptane, heptylene-1, and methyl*cyclo*hexane from the standpoint of yields and poisoning, and, in addition, data on the effect of poisoning by ethylene as a typical olefin. The authors found that initially heptylene-1 cyclizes more rapidly than *n*-heptane, but during the dehydrogenation extremely rapid poisoning of the catalyst occurs. From the reaction of a mixture of 85% *n*-heptane and 15% heptylene-1 it was observed that the presence of the heptylene-1 markedly reduced the conversion rate. The reaction rate of methyl*cyclo*hexane was greater than that of *n*-heptane or the initial stages of heptylene-1, but no poisoning occurred. Ethylene had a pronounced poisoning effect on the dehydrogenations, but the presence of hydrogen suppressed this effect, presumably by rapid hydrogenation to ethane. The effect was due to deposition of carbonaceous material on the surface, and the poison was removable only by oxidation. Poisoning affected much more seriously the aromatic formation than the dehydrogenation of the paraffin to olefin. A general discussion on the mechanism of these reactions is given.
R. D. S.

104. Use of Sulphuric Acid in Purifying Saturated Hydrocarbons : its Action on 2 : 4 : 4-Trimethylpentane. F. C. Whitmore and H. H. Johnson, Jr. *J. Amer. chem. Soc.*, 1941, **63**, 1481–1482.—After treating *iso*-octane with cold 95% sulphuric acid for 10 days the authors found that over half othe starting material had been changed to other products. Although this is a prolonged treatment, and therefore an extreme case, they question the desirability of this method for the purification of saturated hydrocarbons.
R. D. S.

105.* Dielectric Properties of Organic Compounds. S. O. Morgan and W. A. Yager. *Industr. Engng Chem.*, 1940, **32** (11), 1519.—The dielectric constants of a large number of hydrocarbons, halogen compounds, ethers, ketones, esters, and alcohols are given. The relationship between chemical composition, physical structure, and dielectric constant is discussed. The determined dielectric constant of many polar liquids do not agree with the results calculated from chemical constitution, due to association or molecular interaction. In the solid state where simple theory predicts a low dielectric constant, there are many cases of high values. In the case of plastics this phenomena has been more fully investigated, and a correlation is found between the presence of polar groups and the value of the dielectric constant.
J. W. H.

106.* Electrical Conduction in Dielectric Liquids. R. W. Dornte. *Industr. Engng Chem.*, 1940, **32** (11), 1528.—The current-voltage relations at high electrical gradients are given for dry, gas-free heptane and benzene at 23° C. Measurements have been made in uniform and non-uniform electrical fields in cells of different types fitted with different electrodes. The experimental results do not agree with the thermionic emission theory of conduction. The experimental slope was generally greater than calculated value. It was suggested that this lack of agreement is due to the nature of the electrode surfaces. Cold cathode emission of electrodes is suggested as a mechanism for the electrical conduction in dielectric liquids.
J. W. H.

107.* Phase Equilibrium in Mixed Solvent Extraction. A. V. Brancker, T. G. Hunter, and A. W. Nash. *Industr. Engng Chem.*, 1941, **33** (7), 880.—The tetrahedral and right-prism methods of representing the phase equilibrium between four components are discussed. Experimental data are given for the systems chloroform–acetone–

acetic acid–water at 25° C. and oil–acetic acid–chloroform at 25° C. in which the oil is regarded as two components of the system. J. W. H.

108.* Liquid Films in the Viscous Flow Region. J. F. Friedman and C. O. Miller. *Industr. Engng Chem.*, 1941, **33** (7), 885.—Experimental data are given for the flow of fluids down wetted wall-towers. Measurements of the film thickness and velocity have been made at various flow-rates in glass tubes of 1·00 and 0·626 in. dia. with oil, kerosine, toluene, and water as the fluids. The data from these experiments have been correlated with Reynolds number and friction factor. It is considered that in the flow of liquid films bounded by solid and static air interfaces, a third type of flow, named pseudo-streamline, exists between Re 25 and Re 1500. This type of flow is characterized by the appearance of waves in the liquid film and a much higher gas–liquid interfacial velocity than that predicted by the streamline flow equations. The Reynolds number–friction factor relationship for true streamline flow is applicable in this region. The change from streamline to pseudo-streamline is a function of Reynolds number and is independent of the tube diameter. J. W. H.

109.* Calculation of Partial Pressures of Binary Mixtures. R. M. Levy. *Industr. Engng Chem.*, 1941, **33** (7), 1928.—Equations are developed which enable the vapour–liquid equilibrium to be calculated for binary mixtures from a knowledge of the total pressure of the system and the vapour-pressure temperature relationship of the components. Experimental and calculated values of the vapour liquid equilibrium are given for examples which obey and which deviate from the ideal solubility laws. The equations can be applied to the soluble portions of partly miscible liquids.
J. W. H.

110. Olefine Production from Ketones. Anon. *Chem. Tr. J.*, 17.10.41, **109**, 188.—A method of producing olefines from aldehydes and ketones is described in E.P. 538,353 of 1941 granted to the Gas Light & Coke Co. and R. H. Griffith. An aldehyde or ketone (*e.g.*, dipropyl ketone) is treated at *ca.* 400° C. and at atmospheric pressure with an excess of hydrogen in the presence of a deoxygenating catalyst, consisting of a compound of vanadium, tungsten, or molybdenum, preferably the oxides or sulphides. With a catalyst space of 1 litre, 1000 litres of hydrogen/hour are passed through with 1 litre/hour of the ketone. The oxygen in the aldehyde or ketone is removed in the form of water, but saturation of the double bond does not take place unless temperature or hydrogen concentration is too high or time of treatment too prolonged. Satisfactory results are obtained when 10% of the aldehyde or ketone is unchanged. The quantity of hydrogen should be about ten times the theoretical, this being reduced at low throughputs or high temperatures to reduce saturation of the double bond. Increasing the pressure also has the effect of increasing formation of saturated hydrocarbons. The position of the aldehyde or keto-group generally determines the position of the double bond, unless isomerization occurs (which may result from the secondary activity of the substance used as catalyst support). From dipropyl ketone a mixture of C.7 hydrocarbons results, most having one double bond in the molecule. Water, heptanol 4, and fully saturated hydrocarbons are also formed. C. L. G.

See also Abstract No. 82.

Analysis and Testing.

See Abstract No. 118.

Motor Fuels.

See Abstract No. 71.

111. Patents on Motor Fuels. S. B. Grundy. E.P. 539,285, 3.9.41. Appl. 8.3.40. Manufacture of addition agents for incorporation in motor spirits. Naphthalene and a proportion of graphite are mixed together, and during the process of mixing xylidine (amidodimethylbenzene) is incorporated in the form of a fine spray. The resultant powder is then compressed into the form of tablets.

Standard Oil Company. E.P. 539,297, 4.9.41. Appl. 15.12.39. Conversion of saturated straight-chain normally liquid paraffin hydrocarbons into saturated branched-chain paraffin hydrocarbons. The saturated straight-chain hydrocarbons are treated with a catalyst selected from the group comprising aluminium chloride, aluminium bromide, and their hydrocarbon complexes, and a halogen-containing promoter for such catalyst, at elevated temperature, and pressure, and in the presence of one or more normally gaseous saturated paraffin hydrocarbons having at least two carbon atoms per molecule.

Standard Oil Development Co. E.P. 539,383, 8.9.41. Appl. 13.10.40. Treatment of crude petroleum oil to obtain motor fuel of high anti-knock value. The oil is separated into a number of fractions of different boiling ranges. These are then vaporized individually, and a solid pulverulent contact material is suspended in each fraction. The suspensions are then passed through separate reaction zones and maintained under conditions designed to convert the oil fractions into high-grade motor fuel.

Standard Oil Development Co. E.P. 539,480, 12.9.41. Appl. 13.11.39. Production of normally liquid hydrocarbons suitable for use as motor fuel of the kind in which an olefin and an *iso*paraffin are reacted to produce alkylated hydrocarbons. According to this method there is introduced into the reaction mixture a fraction of a previously formed product of such reaction, consisting of hydrocarbons boiling below the final product and hydrocarbons boiling above the final product.

V. G. Strickland. E.P. 539,792, 24.9.41. Appl. 16.3.40. Method of running internal-combustion engines with easily inflammable fuels. The fuel is stored in the form of an emulsion, and is separated from the emulsion only on its way to the engine. It is claimed that fuel stored in this way is is not liable to explode and is particularly suitable for use in aircraft engines, submarines, etc.

M. H. Arveson. U.S.P. 2,257,723, 7.10.41. Appl. 26.1.38. Conversion of petroleum oil into high anti-knock motor fuel by fractionating it into naphtha, virgin gas oil, and reduced crude. Thereafter the reduced crude is thermally converted into tar and light products, including gases and gasoline. The virgin gas-oil is catalytically cracked, and the products therefrom, together with the products from thermal conversion, catalytically cracked to separate gasoline and gases from a first cycle gas-oil. Hydrogen and methane are separated from these gases to obtain a C_3–C_4 hydrocarbon fraction, which is admixed with the first recycle gas-oil. Finally, the mixture is catalytically converted to form a second cycle gas-oil and a high anti-knock gasoline characterized by branched-chain structure.

D. R. Stevens and W. A. Gruse. U.S.P. 2,258,368, 7.10.41. Appl. 19.1.38. Manufacture of a motor fuel consisting substantially of di*iso*butylene and tri*iso*butylene. *iso*Butylene is taken up in 60–65% sulphuric acid solution and polymerized while maintaining the concentration of the sulphuric acid on a hydrocarbon-free basis substantially constant. During polymerization the apparent acidity of the *iso*butylene–sulphuric acid solution is approximately. 45 gm. 95 H_2SO_4/100 c.c. of *iso*butylene–sulphuric acid solution. In this way about 90% of the *iso*butylene is polymerized.

R. M. Melaven and R. V. Shankland. U.S.P. 2,258, 787, 14.10.41. Appl. 25.1.39. Conversion of heavy hydrocarbon oils into gasoline by vaporizing the oils and subjecting the vapours at a temperature between 700° and 1050° F. to the action of a catalyst consisting essentially of silica gel promoted by titanium. The catalyst is made by treating the gel with a titanium compound in an acid solution and afterwards washing and drying.

H. V. Atwell. U.S.P. 2,258,839. 14.10.41. Appl. 10.10.37. Conversion of normally liquid and normally gaseous hydrocarbon products of the reaction of carbon monoxide and hydrogen. A fraction predominating in normally liquid constituents, and including at most a minor proportion of hydrocarbons boiling above the gasoline range, is separated from the reaction products, and a substantial porportion of normally gaseous hydrocarbons mixed with it. The resultant mixture is subjected to elevated conditions of temperature and pressure to effect conversion of normally liquid and normally gaseous constituents thereof to gasoline of high anti-knock value.

E. L. D'Ouville. U.S.P. 2,260,279, 21.10.41. Appl. 21.12.38. **Preparation of a motor fuel containing a large proportion of branched-chain paraffin hydrocarbons from a naphtha containing substantial amounts of aromatic and straight-chain paraffin hydrocarbons.** The naphtha is heated to produce therefrom a hydrocarbon mixture containing straight-chain paraffin hydrocarbons, but not more than 2% by volume of aromatic hydrocarbons. The mixture is then subjected to the action of an aluminium halide catalyst and an activator affording a hydrogen halide under conditions effective to convert straight-chain paraffin hydrocarbons into branched-chain paraffin hydrocarbons.

Le R. G. Story. U.S.P. 2,261,004, 28.10.41. Appl. 27.5.39. **Manufacture of high anti-knock gasoline hydrocarbons by dehydrogenating normally gaseous hydrocarbons** predominating in paraffins containing between two and five carbon atoms, to form a hot mixture of paraffins and olefins. The hot mixture is then contacted with liquid products from an alkylation process, and the liquids thus vaporized to form an alkylate and a normally gaseous hydrocarbon fraction containing olefins and paraffins. The gaseous portion is then fractionated to produce a fraction rich in olefins and a fraction rich in paraffins. The olefin-rich fraction is charged to the alkylation operation, where the olefins are alkylated with *iso*butane in the presence of an alkylation catalyst. The paraffin-rich fraction is returned to the dehydrogenation operation. H. B. M.

Gas, Diesel, and Fuel Oils.

112. Home Fuels for Diesels. Anon. *Gas Oil Power*, July 1941, **36** (430), 144; Aug. 1941, **36** (431), 161.—This is a summary of a report with particular reference to the use of indigenous fuels in road-vehicle oil engines, published by the Diesel Engine Users' Association.

In some general comments on the problem of using home-produced fuels in high-speed diesels, it is pointed out that the S.I.T. of coal oils is higher than those of petroleum-base oils; thus the former are more difficult to ignite in an engine. Dopes have been tried out to overcome this deficiency, including ethyl nitrate, amyl nitrate, and nitrite, and two dopes patented by the Gas Light & Coke Co. and the Low-Temperature Carbonization Co. respectively.

The test fuels used for this work comprised :—

(*a*) 0/100% reference blend : *a* methyl naphthalene/Kogasin II.
(*b*) 0/100% blend : H.-T. creosote/petroleum diesel fuel.
(*c*) 0/100% blend : L.-T. diesel oil/petroleum diesel fuel.
(*d*) Blenders : Diesoline, Esso-Diesel, Scotch shale oil and high-ignition-quality gas oil.

The bench tests were carried out at the Gas Light & Coke Co's Beckton Research Experimental Station on a single-cylinder Lister engine, compression ratio 19 to 1 for starting from cold and 15-25 to 1 for normal working, rated at 9 B.H.P. at 1000 r.p.m.

Results have been plotted in the form of a graph showing the relation between the critical ignition temperatures of the various fuel blends and the engine compression ratio under running temperature conditions. The following indications can be obtained from the graph :—

(i) Proportion of high-temperature or low-temperature creosote diesel fuel which can be blended with a commercial petroleum-base fuel for use in a diesel engine of known compression ratio and temperature limits.

(ii) The minimum compression ratio required to enable a given blend of creosote diesel fuel to be used. Since the compression ratios of standard makes of engine are known, the graph will indicate what engines can run on a given blend.

It was found that the high-temperature creosote blends require a higher temperature of ignition than either the reference or the low-temperature blends. Conversely, a given engine will require a higher percentage of high-grade fuel in the blend than would be necessary if either the reference or low-temperature creosote blends were being used.

It is concluded that:—

1. Straight H.-T. creosote cannot be satisfactorily used in present commercial transport engines.

2. Doping this fuel improves its performance, the effect of 4% dope being equivalent to a 40% addition of petroleum diesel fuel.

3. Although bench tests allow up to 50% H.-T. creosote in a fuel, in practice 20% creosote probably represents the limit. Even then a dual fuel system is necessary for starting from cold.

4. Under some conditions straight L.-T. creosote can be used and doping gives satisfactory results.

5. With L.-T. creosote 50% blends are more or less satisfactory.

D. L. S.

113. Patent on Gas, Diesel, and Fuel Oil. E. T. Scafe. U.S.P. 2,261,003, 28.10.41. Appl. 5.12.39. Preparation of an unrefined light fuel oil of gas-oil nature inhibited against the formation of sediment by oxidation under normal conditions of storage by the addition of small amounts of di*cyclo*hexylamine. H. B. M.

Lubricants and Lubrication.

114.* Anti-Friction Bearing Lubricants. O. L. Maag. *Nat. Petrol. News*, 1.10.41, **33** (40), R.313.—The author advocates the introduction, for industrial lubricants, of a classification system similar to the S.A.E. system for motor oils. The relative merits of oils and greases are discussed and a specification for an all-the-year-round grease for army use is suggested. H. G.

115.* Patents on Lubricants and Lubrication. Standard Oil Co. of California. E.P. 539,293, 4.9.41. Appl. 15.11.39. Preparation of a hydrocarbon lubricating oil having incorporated therein a metal phenate and a salt of an organically substituted acid of phosphorus. It is claimed that oils of this character improve lubrication and operation of internal-combustion engines.

B. H. Lincoln and G. D. Byrkit. U.S.P. 2,257,750, 7.10.41. Appl. 24.5.39. Preparation of a lubricant consisting of a major proportion of a lubricating oil and a minor proportion of an organo-metallic salt of a sulphur-bearing organic acid.

B. H. Lincoln and G. D. Byrkit. U.S.P. 2,257,751, 7.10.41. Appl. 5.7.41. Preparation of a lubricant consisting of a major proportion of a lubricating oil and a minor proportion of a tin salt of a sulphurized carboxylic acid. The carboxylic acid is sulphurized by treatment with sulphur chloride.

B. H. Lincoln and G. D. Byrkit. U.S.P. 2,257,752, 7.10.41. Appl. 5.7.40. Preparation of a lubricant consisting of a major proportion of a lubricating oil and a minor proportion of a salt of a quaternary ammonium base and a sulphur-bearing organic acid.

R. G. Sloane. U.S.P. 2,257,890, 7.10.41. Appl. 3.10.33. A sufficient quantity of an aromatic compound containing only the elements carbon, hydrogen, and sulphur is combined with a highly viscous mineral oil to reduce the tendency of the oil to form acidic material through oxidation.

H. M. Fraser. U.S.P. 2,257,945, 7.10.41. Appl. 24.5.40. Removal of entrapped air from lubricating grease by dividing the grease into a number of small streams and subjecting to a vacuum. In this way air is quickly removed from the grease streams.

C. M. Loane and B. H. Shoemaker. U.S.P. 2,257,969, 7.10.41. Appl. 18.5.39. Preparation of a lubricant containing a small amount of an organic sulphone of the general formula

R and *R'* are radicals selected from the group consisting of aliphatic radicals, alicyclic radicals, aromatic radicals, and hydrocarbon substituted aliphatic, *cyclo*aliphatic, and aromatic radicals.

L. G. Burns. U.S.P. 2,258,202, 7.10.41. Appl. 16.5.40. Preparation of a lubricant having incorporated in it graphite (2 parts per 100), bentonite (98 parts per 100), and sufficient water to render the mixture of graphite and bentonite free flowing.

A. J. Morway and A. Beebower. U.S.P. 2,258,301, 7.10.41. Appl. 11.5.38. Preparation of an anhydrous grease consisting of a soda soap of a fatty acid, lubricating oil, and a small amount of plasticizing agent comprising a non-distillable, substantially neutral saponifiable material obtainable as a by-product of the oxidation of paraffin wax. The amount of this neutral by-product is less than half that of the acid used in making the soap.

J. C. Zimmer. U.S.P. 2,258,309, 7.10.41. Appl. 7.4.38. Preparation of a lubricant consisting of an aqueous emulsion of a mineral lubricating oil to which has been added a filler consisting of a polyvalent metal salt of an acid selected from the class consisting of phosphoric, boric, and hydrosulphuric acids. This salt is substantially insoluble in both oil and water.

F. R. Moser and A. J. Dijksman. U.S.P. 2,258,591, 14.10.41. Appl. 27.11.39. Preparation of a compounded mineral lubricating oil of improved anti-corrosive properties and containing a small amount of the zinc salt of di-*iso*propyl salicylic acid.

M. Pier and F. Christmann. U.S.P. 2,258,806, 14.10.41. Appl. 19.1.35. Preparation of a lubricant consisting of a synthetic product of high molecular weight prepared by condensation, by means of a catalyst of the Friedel–Crafts reaction, a mixture of an organic compound selected from the class consisting of unsaturated and halogen-containing compounds having a long hydrocarbon chain, and a substance selected from the class consisting of elementary sulphur and reactive organic sulphur compounds possessing anti-oxidant properties.

H. G. Berger, W. H. James, and D. E. Badertscher. U.S.P. 2,259,452, 21.10.41. Appl. 2.8.39. Preparation of an improved mineral-oil composition consisting of a mineral-oil fraction and a small amount of a compound selected from the group consisting of an aromatic *ortho*-phosphite-carboxylic acid chloride and derivatives thereof.

E. F. Engelke. U.S.P. 2,260,303, 28.10.41. Appl. 8.5.39. Preparation of a lubricant consisting of a hydrocarbon oil and a condensation product of an organic phosphine formed in the presence of sulphur and containing at least two organic phosphine radicals in the molecule.

E. F. Engelke. U.S.P. 2,260,304, 28.10.41. Appl. 15.9.39. Preparation of a lubricating composition consisting of a lubricating oil to which has been added a small proportion of a nitrogen-free organic chlorophosphine oxide in which chlorine is directly attached to phosphorus.

J. E. Schott. U.S.P. 2,260,341, 28.10.41. Appl. 5.4.38. Manufacture of a lubricating composition consisting of hydrocarbon oil of suitable viscosity compounded with approximately 1% by weight of aluminium stearate and a quantity of hydroxy butyloxy-ethyl ether, sufficient to improve the lubricating efficiency of the oil. The ingredients of the compounded oil are subjected to a heat treatment at an elevated temperature and for sufficient length of time to produce a resulting product which has substantially the viscosity and fluidity characteristics of the uncompounded oil.

P. A. Asseff. U.S.P. 2,261,047, 28.10.41. Appl. 28.7.41. Preparation of a lubricating composition consisting of a major proportion of a hydrocarbon oil to which has been added a small amount of the zinc salt of an acidic reaction product obtained by reacting phosphorus pentasulphide with an alkylated *cyclo*hexanol in which substantially all of the alkyl groups have less than six carbon atoms.

H. B. M.

Asphalt and Bitumen.

116.* Mechanics of Granular and Granular-Plastic Materials, with Special Reference to Bituminous Road Materials and Subsoils. V. A. Endersby. *Proc. 43rd A.M., A.S.T.M.*, 1940, **40**, 1154–1173.—This paper is a study of the mechanical stability of bituminous mixes by evaluation with the Mohr circle diagram, of results obtained in the triaxial test on road-mix samples. It is shown that, in correlating tests with practical conditions, the absolute dimensions and composition of the specimen, the maximum particle size, the temperature, and the speed must be considered.

Friction-deformation and void-deformation curves for various aggregates, and Mohr diagrams for bituminous mixes, showing the effect of the factors mentioned above, are given. J. F. T.

117.* Measurement of the Deformation Properties of Asphalts. T. F. Ford and K. G. Arabian. *Proc. 43rd A.M., A.S.T.M.*, 1940, **40**, 1174–1181.—The inadequacy of the penetration tests and other empirical tests in evaluating the deformation properties of asphaltic bitumens, particularly those which are elastic as well as viscous, led the authors to investigate the value of a rotating-cylinder viscosimeter. This instrument is provided with conical bases to the cylinders to eliminate end effects. Results of viscosity determinations using different shearing stresses and varying clearance between the cylinders were in good agreement when examining petroleum resins. Deformation–deformation rate curves for Mexican-blown bitumen show that the deformation obtained by the penetration test bears no direct relation to viscosity, and that capillary viscosimeters are unsuitable for the examination of deformation behaviour.

A simpler type of rotating cylinder viscosimeter is described, consisting of two concentric rings, of which the outer one is stationary and the inner one is rotated by weights on a fish-line round the driving pulley, both rings being removable, so that the clearance area and, hence, the shearing stress can be varied. The viscosities of petroleum resins of penetration 12–257 determined on this instrument compared with results obtained by the coni-cylindrical viscosimeter show agreement varying between 1% and 4%.

From an analysis of the deformation curves for Mexican-blown bitumen it is concluded that the minimum data from which such curves can be prepared necessitates a knowledge of three properties such as viscosity, elasticity in shear, and rate of slip. J. F. T.

118.* Rheological Interpretation of Asphalt Tests. R. N. Traxler, H. E. Schweyer, and J. W. Romberg. *Proc. 43rd A.M., A.S.T.M.*, 1940, **40**, 1182–1194.—The relation between the rheological properties of asphaltic bitumen and its colloidal nature, together with problems arising out of the elasticity and thixotropy of the bitumen, is discussed in order to show the unsatisfactory nature of the penetration, ring-and-ball softening point, and ductility tests in evaluating the flow properties of bitumen. From data and curves relating the consistency in absolute units with these three empirical factors, the penetration test is considered to be of little value, the ring-and-ball softening point test is shown to be satisfactory in the case of steam-refined and air-blown bitumens, although not for vacuum or steam-refined bitumen with high-temperature susceptibility, while the ductility test, owing to the effect of temperature and variations in the rate of shear, is considered to bear no relation to any specific property.

In conclusion, the authors urge the substitution of empirical tests by rheological methods of which the rotating cylinder viscometer with variable rates of shear is recommended. J. F. T.

119.* Study of the Recovery of the Bitumen from Soft Asphalt Cements by the Bussow Method. C. Bussow. *Proc. 43rd A.M., A.S.T.M.*, 1940, **40**, 1201–1205.—In order to examine the influence of the maximum temperature of distillation on the penetration of the bitumen recovered by the Bussow method, details of which are given, nine bitumens of penetration 49–270 were recovered, using maximum recovery temperatures of 225°, 250°, 275°, and 300° C., and the penetration, loss on heating, and

penetration after heating of the recovered bitumens determined. The results, when compared with the original figures, indicated that a maximum temperature of recovery of 250° C. is suitable for all these bitumens except for that with a penetration of 270.

The paper concludes by comparing the Abson and Bussow methods, and offers an explanation, based on the difference in solubility of the various components of the bitumen, for the loss in ductility of bitumens recovered by the Abson method.

J. F. T.

120.* **Corrosion of Bituminous-Coated Metal Surfaces.** A. O. Beckman, R. M. Badger, E. E. Gulletson, and D. P. Stevenson. *Industr. Engng Chem.*, 1941, **33** (8), 989.—Electro-osmosis and ionic diffusion are shown by a series of experiments to be almost negligible factors in the type of corrosion encountered in practice. Data given on wetting angles between bitumens and aqueous solutions indicate that imperfections of the order of 0·1 mm. in radius in some bituminous coatings will permit the intrusion of water through an appreciable thickness of film. It is concluded that it is the presence of these small fissures in the coating which is the dominant factor governing corrosion.

J. W. H.

121.* **Permeability and Absorption Properties of Bituminous Coatings.** A. P. Anderson and K. A. Wright. *Industr. Engng Chem.*, 1941, **33** (8), 991.—Although bituminous coatings are shown to be permeable to water and oxygen by molecular diffusional processes, the rate of permeation is so slow as to give rise to a negligible rate of corrosion. It is concluded that asphalt will be effective in preventing the corrosion of coated metal pipes as long as the asphalt coating is macroscopically intact.

J. W. H.

122.* **Study of Bituminous Mixtures on Road-Testing Machines.** C. Mack. *J. Soc. chem. Ind.*, 1941, **60**, 111–120.—The necessity of surfacing a vast mileage of secondary roads in North America has led to the use of low-cost materials which must stand a range of − 30° F. to 100° F. in the shade. Bitumens of consistency 70–100° F. (R. & B.) have been found suitable and difficulties in summer overcome by the use of graded aggregate. Owing to the continual presence of water, the adhesion between bitumen and aggregate must remain high for the roads to be satisfactory. The paper deals with the problem of increasing this adhesion, which has been correlated with the stability of paving mixtures when tested on road-testing machines under various operating conditions. The author discusses the theory of adhesion between bitumen and aggregate and describes a method of measuring adhesion by allowing the powdered solids to settle freely in a 40–60% solution of the bitumens in benzene. It is pointed out that a factor overlooked by many investigators is the presence of the exchangeable sodium and potassium ions. These form soaps with the acids in the bitumen, and water penetrating through will wash off the bitumen. It has been found that heavy metal soaps, particularly lead, added to the bitumen increase the adhesion, as do additions of hydrated lime to acidic aggregates and inorganic heavy metal salts, particularly lead nitrate, to aggregates with exchangeable sodium and potassium ions. Owing to the difficulty of precoating with heavy metal salts, the use of the double salts of heavy metals containing organic radicals of low and high molecular weight was developed—*e.g.*, lead acetate–naphthenate. It requires the presence of high-molecular-weight organic acids or their metal soaps to make it soluble in bitumen. The use of road-testing machines with the pavement kept drenched affords a practical method of testing adhesion as well as the effect of temperature, traffic, etc. The two machines used are described in detail; one has a single traversing wheel, while the other has four overlapping traversing wheels. Careful temperature control during the tests was found to be essential, while decreasing temperature increased the stability of a test paving mixture. The addition of the adhesion-increasing agents described above was found to give a considerable increase in the life of a bituminous-test paving mixture with both the road-testing machines. The effect of temperature on the relative improvement obtained by these adhesion-increasing agents was found to be much more pronounced on one machine. Increasing the speed of the wheel was found to result in an increase of stability which was higher than would correspond to the ratio of the speeds. The results have been correlated between the two machines, and for the same paving mixture the comparison seemed to indicate that the stability was influenced by (1) temperature,

(2) the adhesion of bitumen to aggregate, (3) the speed of the wheel, (4) the amount and distribution of the traffic, (5) the surface contour of the pavement, and (6) the scuffing action of the wheel. Other factors still remain to be investigated. In view of the difficulty in controlling all of the factors affecting the stability of a pavement on the road, it seemed to the author to be impossible to correlate road results with those obtained on the machines, and that considerably more knowledge must be obtained before this could be achieved. H. G. W.

Special Products.

123.* Electrical Insulating Oil Deterioration. J. C. Balsbaugh, A. H. Howell, and A. G. Assaf. *Industr. Engng Chem.*, 1940, **32** (11), 1497.—Two series of related samples of insulating oils have been studied for their oxidation and electrical stability. The samples in these series represent different degrees of solvent refining and finishing treatment of a given stock. The results show that the stability depends on the initial chemical constitution and the refining treatment. Full details of the experimental technique employed, together with details of the effect of oxidation time on the electrical stability, are given. J. W. H.

124.* Liquid Dielectrics. J. D. Piper, C. C. Smith, N. A. Kerstein, and A. G. Fleiger. *Industr. Engng Chem.*, 1940, **32** (11), 1510.—Various compounds representing types of sparingly soluble oxidation products formed during the service degradation of insulating oils have been added to liquid paraffin in proportions to form homogeneous or heterogeneous systems with change of temperature. The power factor, dielectric constant, and conductivity of the system were measured at different temperatures. Homogeneous systems gave low power factors and conductivities. Liquid heterogeneous systems gave higher power factors, which were much higher than that predicted by the Wagner concept of a heterogeneous dielectric. Crystalline heterogeneous systems showed no increase of power factor over the corresponding homogeneous system. J. W. H.

125.* Electrical Stability of Oil-Impregnated Paper. C. E. Trautman and W. N. Arnquist. *Industr. Engng Chem.*, 1940, **32** (11), 1535.—The relationship between the properties of the impregnating oil and the resulting electrical stability of the oil-impregnated paper have been investigated for oils representing various degrees of refining treatment of a Texas Coastal oil. For these oils the power-factor stability and high-voltage life of the paper were found to be related to the specific dispersion. No general relationship between specific dispersion of other oils and electrical stability has been found, and it is assumed that this is due to the presence of small amounts of materials which have no effect on the specific dispersion or Waterman analysis. The addition of an anti-oxidant to the refined oils improved the power-factor stability. J. W. H.

126.* Synthetic Chemicals in Fuels and Lubricants. W. G. Whitman, *Industr. Engng Chem.*, 1941, **33** (7), 865.—A general review is given of synthetic petroleum products under the headings anti-knock agents, anti-oxidants, metal deactivators, cetane improvers, pour-point depressors, anti-lacquers, and extreme pressure improvers for lubricating oils and aviation-fuel blending components. J. W. H.

127.* Plastics and Chemicals from Petroleum Bases. R. L. Wakeman. *Nat. Petrol. News*, 23.7.41, **33** (30), R.226–R.232, R.237.—The past 20 years have seen very rapid strides in the growth of a chemical industry within the petroleum world. This progress has been made possible by the great advances made in the technique of refining and by the widespread introduction of cracking processes which have made "cracked" gases available in large quantities. The list of products prepared from raw materials of exclusively petroleum origin is large, at least as large as that of materials derived from coal-tar products.

It is estimated that in 1940 the total of organic chemicals prepared from the former source exceeded that from the latter by more than twice. These figures may, however, refer to America only. The list includes a wide range of plastics, solvents, dyestuffs, detergents, wetting agents, and pure organic chemicals. The five principal ways in which the paraffinic constituents of petroleum and natural

gas are converted into chemicals are: Pyrolytic cracking followed by chemical reaction, oxidation with steam, CO_2 or atmospheric oxygen, chlorination, nitration, and sulphonation. Ethylene is probably the most important raw material. A wide variety of plastics and intermediates is made from it. The chlorination of pentane leads to amyl chloride and mono-, di-, and tri-chlorpentane. 1 : 3-Dichloropropane is prepared as an intermediate for *cyclo*propane, a promising anæsthetic. The production of nitromethane, nitroethane, and nitropropane by vapour phase nitration is now possible on a large scale. The present scope of their application is not relatively large, but rarely has a new group of chemicals been made available without their ultimately filling an important place in industry or commerce. H. G.

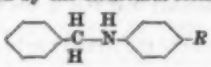
128. Patents on Special Products. Standard Oil Development Co. E.P. 539,252, 2.9.41. Appl. 9.5.40. Manufacture of alkyl halides by the reaction of olefins with hydrogen halides. The reaction is conducted in the presence of a solution of an aluminium halide catalyst in an inert solvent. The catalyst is sufficient to effect the reaction, but does not exceed 2%.

Shell Development Co. E.P. 540,004, 1.10.41. Appl. 27.2.41. Production of aliphatic dicarboxylic acids by the oxidation of an alicyclic hydrocarbon or cyclic ketone with a nitric acid solution. Operating conditions, and particularly the nitric acid concentration, are controlled by a novel procedure, so as to obtain high yields of the desired aliphatic dicarboxylic acids with minimum consumption of nitric acid.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 540,022, 2.10.41. Appl. 28.3.40. Production of aromatic hydrocarbons from mixtures of paraffins and *cyclo*paraffins having more than 6 and less than 12 carbon atoms in the molecule by catalytic cyclization and/or dehydrogenation to increase the octane number. *cyclo*Paraffins with a non-hydroaromatic character, especially *cyclo*pentane homologues, are substantially removed from the initial material before cyclization or dehydrogenation.

Standard I.G. Co. E.P. 540,045, 3.10.41. Appl. 6.2.40. Preparation of paraffin–olefin mixtures by incomplete dehydrogenation of paraffins or paraffin–olefin mixtures of low olefin content. The original hydrocarbons are subjected to temperatures above 500° C. in the presence of a hydrogen halide. 1–10 mols. of hydrogen halide are employed to 1 mol. of paraffin.

C. E. Trautman. U.S.P. 2,257,869, 7.10.41. Appl. 22.3.40. Preparation of a transformer oil composition consisting of transformer oil and a small amount of a dissolved compound represented by the structural formula



where R is selected from the class consisting of methoxy and ethoxy groups.

C. E. Trautman. U.S.P. 2,257,870, 7.10.41. Appl. 31.10.40. Preparation of an electrical insulating-oil composition consisting of a petroleum oil having a stabilizing amount of an alkali-insoluble 2 : 4 : 6-trialkylated monohydroxyphenol and a stabilizing amount of *N*-tetrahydrofurfuryl-*p*-aminophenol dissolved therein.

C. E. Trautman. U.S.P. 2,257,871, 7.10.41. Appl. 9.11.40. Incorporation of a small amount of triphenyl phosphate in petroleum oil used as a dielectric and cooling medium in the operation of electrical transformers. The addition of triphenyl phosphate substantially inhibits oxidational changes which would otherwise take place in the oil during normal conditions of use.

C. E. Trautman. U.S.P. 2,257,872, 7.10.41. Appl. 9.11.40. Improvement in transformer oil by the addition of relatively small amounts of trithiophenyl phosphate and of 2 : 6-di-*tert.*-butyl-4-methylphenol. The oil is claimed to be highly resistant to sludging and to other oxidational deterioration under service conditions.

A. N. Sachanen and R. C. Hansford. U.S.P. 2,257,920, 7.10.41. Appl. 20.1.39. Production of alkyl aromatic hydrocarbons boiling below 300° C. from a petroleum tar comprising a substantial amount of alkyl aromatic hydrocarbons entirely of petroleum origin. The alkyl aromatic hydrocarbons are treated with benzene in the presence of a metal halide catalyst at a temperature between 80° and 200° C.

L. T. Monson and W. W. Anderson. U.S.P. 2,259,704, 21.10.41. Appl. 12.5.40. Process for breaking petroleum emulsions of the water-in-oil type. The emulsion is subjected to the action of a demulsifying agent consisting of a mixture of an acylated amino-ether, a blow fatty oil, and a sulphonated fatty body substantially neutral to methyl orange indicator.

W. K. Griesinger and B. Bettmann. U.S.P. 2,259,885, 21.10.41. Appl. 6.4.38. Manufacture of a water-soluble petroleum carbocyclic aminosulphonic acid having at least one nuclear side-chain substituent containing from 3 to 12 carbon atoms. To prepare this acid a petroleum distillate fraction is treated with sulphuric acid to effect sulphonation of at least part of the distillate. Unreacted distillate is then separated from acid sludge and the latter treated with a nitrating agent. Nitrosulphonic acids are extracted from the nitration mixture with an organic solvent and the aqueous solution of acids neutralized with sodium hydroxide. Finally the sodium nitrosulphonates are treated with a reducing agent to reduce them to aminosulphonates.

C. F. Bonnet. U.S.P. 2,259,995, 21.10.41. Appl. 30.1.40. Process for breaking petroleum emulsions of the water-in-oil type. The emulsion is subjected to the action of a demulsifying agent containing a nitroso-aromatic compound selected from the group consisting of nitroso-phenols and nitroso-aromatic carboxylic acids.

A. Pott and H. Broche. U.S.P. 2,261,075, 28.10.41. Appl. 3.6.38. Method of treating dry pulverulent bituminous coal extract to improve its use for motor fuel. The softening point is lowered and ignition temperature lowered by treating with oxygen containing gas at high temperatures. H. B. M.

Detonation and Engines.

129.* Instrument for Measuring Ignition Quality of Diesel Fuels. W. H. Browne. *Soc. Aut. Engrs J.*, 1941, **48** (4), 148–153.—This paper describes the development and use of the Caterpillar cetane valve, an instrument for measuring cetane ratings by throttling the intake air of a single-cylinder test engine. The valve consists of a straight-edged gate sliding across an orifice of varying width. The shape of this orifice is such that a straight-line calibration exists between gate movement and cetane number. Thus, only two reference fuels are needed for standardization. The method of use is to close the orifice gradually until a misfire occurs. When the instrument has been calibrated this misfire point gives the cetane rating of the fuel. As it is important to traverse the gate at a uniform rate, a small electric motor is used.

It is claimed that an operator can rate six to eight fuels an hour on the Caterpillar engine. On the C.F.R. engine the misfire point is not sufficiently definite for the present design of cetane valve to be applied. K. A.

Coal and Shale.

130.* Electrostatic Charges on Coal Particles in Oil. J. E. Hedick, A. C. Andrews, and J. B. Sutherland. *Industr. Engng Chem.*, 1941, **33** (8), 1055.—Under the impress of an electric current, coal particles in oil suspension show a line of force arrangement. Both positive and negative charges exist in the same suspension, not only on different particles, but on different areas of the same particle. These charges are produced by the friction during grinding. Stabilizing addition agents are of two types, surface-acting compounds which prevent flocculation by their electrical effects and mechanical agents which hold a particle in suspension by the formation of gel structures. The mobilities of suspended coal particles have been determined, and are shown to lie between 1·0 and 7·7 $\times 10^{-5}$ cm./sec./volt. J. W. H.

131.* Hydrogenation of High-Volatile Bituminous Coals. L. L. Hirst, R. L. Boyer, A. Eisner, I. L. Pinkel, and H. H. Storch. *Industr. Engng Chem.*, 1941, **33** (8), 1068.—The results are given of liquid phase hydrogenation of assays of four bituminous coals in the Bureau of Mines experimental plant. A summary of similar data obtained for eight bituminous coals, three sub-bituminous coals, and two lignites is also given. J. W. H.

BOOK REVIEW.

Possible Future Oil Provinces in the United States and Canada. By the American Association of Petroleum Geologists. Pp. 154. A.A.P.G., Tulsa, Okla. Price $1.50.

This volume, of only 154 pages, records the results of a symposium conducted by the Research Committee of the American Association of Petroleum Geologists in April 1941. Despite its small size, the volume constitutes a peak even on the high plateau of achievement of this leading association of petroleum geologists.

The project of obtaining and recording a bird's-eye view of the main undiscovered petroleum resources of the United States and Canada was characteristically bold in conception, and the volume under review bears ample testimony to the excellence of its execution. The contributors to the symposium include five geological societies, the Alberta Society of Petroleum Geologists, the Pacific Section of the A.A.P.G., the Geological Survey of Canada, the Quebec Bureau of Mines, and the Chief Alaskan geologist, U.S. Geological Survey. These organizations are responsible for their respective contributions to the volume, and behind them are the best specialists in the United States and Canada. Each and every article in the volume therefore bears the stamp of the highest authority.

Nine main petroliferous provinces are dealt with, but a few regions have been omitted, as present information regarding them is too meagre to allow of authoritative presentation of the evidence.

The description of the petroliferous provinces is preceded by a characteristically thoughtful foreword by the Chairman and Editor, who is probably the leading exponent of the philosophy underlying geological exploration. He sets out four fundamental criteria which form the basis of the articles, and which should be satisfied if a province or region is to rank as being capable of supporting many deposits of oil of commercial size.

The first criterion is the volume and character of the sediments. Volume of sediments is doubtless of the first importance in estimating the petroleum possibilities of any country or province, and it would seem to be specially applicable to the United States, which is unique in that practically every system in the geological column is petroliferous. The disposition of the sediments with respect to the general geological structure is important as, owing to this factor, different provinces and also different parts of a single province may have quite different prospects, which are by no means proportional to the respective volumes of the sediments. The character of the sediments is an important consideration, as is shown by the fact that some of the areas described in the volume under review contain a considerable proportion of continental deposits, the prospects of which are relatively slight or non-existent. However, provided that the succession in a province includes formations that could have functioned as source-rocks, reservoir-rocks, and cap-rocks, the criterion of volume of sediments is of fundamental importance.

The second criterion is that of evidences of oil and gas. This criterion is obviously of the greatest importance, and the gas and oil indications should be studied closely in relation to possible source-rocks and cap-rocks, as this relationship may throw much light on the extent of lateral and vertical migration of the oil and gas, and thus on the stratigraphical positions of possible accumulations of oil in structures and in stratigraphical traps.

The third criterion is the presence of unconformities, which are of great importance in relation to the creation of conditions suitable for the formation of oil, and for its subsequent lateral migration and accumulation in structures and stratigraphical traps.

The fourth criterion is the existence of regional wedge-belts of porosity, which are specially important in the case of extensive shore-line deposits which have been effectively concealed by the unconformable overlap of younger formations.

A deep and large basin, trough, or synclinorium, constituting the whole or a portion of a geosyncline, provides the best general geological setting for the preservation of an enormous volume of sediments, and also for the extensive lateral

migration of oil and gas in all directions to the usual marginal and occasional interior structures, and also to any stratigraphical traps that may be present on the foreland side of the original geosyncline. Moreover, the considerable temperatures and high pressures resulting from the burial of sediments to great depths in such basins and troughs probably aided the migration of oil and gas. Indeed, the burial of thick argillaceous sediments may have had some bearing even on the later stages of the formation of oil. These considerations lead to the possibility that the four criteria of the foreword are among the usual and interrelated consequences of the deposition of sediments in a geosyncline. Discussion of the total results of sedimentary deposition in this environment might lead to the detection and formulation of subsidiary criteria, and might even show that all the criteria are so interlocking and consilient as to leap together in the unity of a single and simple hypothesis. In any case, further discussion of the best working criteria for the appraisal of the prospects of large areas or provinces would be of the greatest interest and value to petroleum geologists.

It is impossible in a brief review to attempt to do justice to the individual articles of the volume. They are excellently well presented and amply illustrated by maps and sections. It is possible that one or two of them show slight effects of an attempt to squeeze a quart into a pint-pot, but considerations of space doubtless rendered such compression unavoidable. The articles are perhaps more uniform in quality and method of treatment than might have been expected in a series of articles on different provinces by different authorities; the slight and unavoidable differences in the presentation of evidence and in the approach to the subject of prospects being negligible in view of the great value of the volume as a whole.

Although space precludes special reference to particular areas, attention must be directed to the very striking circumstance that many of the areas dealt with are the interior or central parts of basins, the marginal structures of which support oil-fields. These areas present a difficult and important problem in the science and art of discovery as, owing to the very thick succession of deposits, the absence of any signs of structure in the superficial formations, the presence of concealed unconformities, and the great depths to known oil-bearing horizons, very great difficulties exist in the way of locating suitable deep structures and stratigraphical traps.

The oil measures of the United States are unique in respect of their very wide geological range and their extensive geographical distribution. It is therefore fortunate that the great opportunities provided by these features have been matched by the enterprise of the pioneers and later prospectors, with the result that the number of proved oil-fields is legion. The student of the petroleum geology of the United States is therefore usually perplexed, and even overwhelmed, by the magnitude and complexity of the data with which he is confronted, with the result that he is unable to see the wood for the trees. This small volume, dealing as it does with fundamental considerations only, presents a bird's-eye view in which the outlines of the forests are clearly defined, so that each wood and even the striking individual trees fall into their proper places and are seen in true perspective. For this reason alone the book is an indispensable preliminary guide to the study of the petroleum geology of the greater part of North America. It is true that the authors had no intention of producing a volume that would be useful as a guide, but nevertheless they have provided the indispensable skeleton to which all the other parts can be fitted.

By the publication of this volume the American Association of Petroleum Geologists has performed an outstanding service to petroleum geology, and has placed all petroleum geologists in its debt. The volume is a stimulus to the study of the philosophy of geological exploration, and provides much comprehensive data by means of which this philosophy may be enriched. Moreover, since the avowed purpose of the symposium was to outline the major undiscovered petroleum resources of the United States and Canada, it follows that the volume provides a valuable and indispensable preliminary guide to all who are in any way interested in these possibilities.

T. DEWHURST.

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Geology and Development

132.* Regional Stratigraphy of Mid-Continent. R. H. Dott. *Bull. Amer. Ass. Petrol. Geol.*, September 1941, **25** (9), 1619–1705, including bibliography.—The Mid-Continent is taken as extending from South Dakota and Iowa to the north part of Texas. Maps are provided indicating the surface and underground occurrences of different formations. The influence of buried ridges, folds of various ages, and lateral variation of

facies, in determining oil distribution, is fully outlined, with numerous references to authors. Pre-Cambrian (? Algonkian) rocks appear in the Sioux Falls uplift, South Dakota, which stretches underground into Iowa. They form buried cores in the Cambridge anticline and Chadron dome, Nebraska, and in the Nemaha ridge, which trends south-west into North-central Kansas, intersecting almost at right angles the Central Kansas uplift, under the oil-fields of which there is a floor of pre-Cambrian granites and schists. Another such ridge runs north–south near the western boundary of Missouri, and pre-Cambrian rhyolites break the surface in the St. Francois Mountains. The Spavinaw district, Oklahoma Ozarks, has small ancient outcrops; peaks in granite and domes may yield oil—*e.g.*, Cushing Field. Pre-Cambrian has also been penetrated in North-west Arkansas at 2485 ft. The line of uplift in Southern Oklahoma, with pre-Cambrian exposed in the Arbuckle and Wichita Mountains, continues underground both east–south–east and west–north–west. The Amarillo oil-fields, in the north corner of Texas, lie on this strike. Pre-Cambrian approaches the surface in the Pecos and Red River uplifts, and it has a shelving descent from outcrop in the Llano district, Texas.

The Cambrian is very extensive, usually beginning with conglomerates and sandstones, sometimes glauconitic, and passing up into thick limestones and dolomites, within which, as in the case of the Ellenburger and Arbuckle formations, lies the Cambro-Ordovician boundary. Only in the Ouachita Mountains of Oklahoma and Arkansas is the Cambrian notably shaly. There the graphitic Collier muds are succeeded by the Crystal Mountain sandstone, and in subsequent Palæozoic deposits a distinctive shale and chert facies persists. The Cambrian is absent apparently in the Sioux Falls area, over the Nemaha ridge, in part of Western Missouri, in the Spavinaw district, and at least in places in West Texas. Economically Cambrian sandstones yield water for many towns.

The Ordovician is still more widespread. In the Llano uplift only Lower Ordovician occurs, but elsewhere nearly complete successions are found. Except in the Ouachita basin, which is continued underground into North-east Texas, the typical column comprises dolomites, limestones, sandstones, and shales. The Ordovician is to some extent planed off by pre-Mississippian erosion in North-east Oklahoma and South-east Kansas, and is partly removed by pre-Pennsylvanian erosion in Western Kansas. On the Red River arch and other Texan "highs" it is entirely denuded by pre-Pennsylvanian erosion. The formation is prolific of oil and gas, especially in Kansas, in the "siliceous lime" of the Arbuckle Group (Lower Ordovician), which produces most when separated by Simpson beds (Middle Ordovician) from the Pennsylvanian unconformity, and in Oklahoma in the "Wilcox" sand, a probably diachronous sandy facies, as well as at other horizons, in the Simpson Group. Yields are likewise obtained in North and West Texas. The Viola limestone, of Trenton age, thins rapidly northward from the Arbuckle Mountains, but limestone of equivalent date reappears in the Falls City field, South-east Nebraska, and has yielded some oil. More persistent over the Mid-Continent is the Fernvale limestone, of Richmond age (Upper Ordovician), valuable for structural mapping, and often confused with the Viola.

Silurian and Devonian are both absent in the Llano uplift and in the Wichita Mountains. They are relatively restricted and thin, and are very incomplete compared with the standard New York section, but thicken towards Iowa and Missouri. Numerous limestones are present, though not in the Blaylock sandstone and unfossiliferous Missouri Mountain slate of the Ouachitas. In Oklahoma oil is obtained from the "Hunton," a term that represents both Silurian and Devonian. The "Hunton" underlies most of Central and Western Oklahoma, except in "highs" along the Central Oklahoma uplift. In part of the Greater Seminole area, where not removed by denudation, it is an important producer. It also yields, as in the Salina basin, in Kansas, and in the Forest City basin, opened commercially in 1939, in South-east Nebraska. There is Silurian over much of the latter State, though not on the Chadron and Cambridge anticlines, whilst the Devonian seems to wedge in only in the east.

In the Llano uplift the basal part of the Mississippian is missing, and the Chappel limestone, of Osage age, is only a few feet thick, resting on Ellenburger, and disconformably succeeded by the Barnett shale, in the upper strata of which there are Pennsylvanian fossils. In the Wichita Mountains no Mississippian outcrops. In the Ouachitas the Upper Talihina chert, synchronous with Upper Arkansas novaculite,

belongs to the Lower Kinderhook, at the bottom of the Mississippian, and there follows an interval of non-deposition. Elsewhere the Mississippian is well represented. It begins with irregular sandstones, Sylamore and Missner, the latter of which in Oklahoma, Kansas, and at Falls City, Nebraska, gives a varying quantity of oil. These sandstones occur locally at the base of the black, fissile, Chattanooga shale, a richly organic "oil mother," which rests on planated older rocks from Middle Devonian down to Ordovician. The United States Geological Survey treat the Chattanooga as "Devonian (?)," but it is more convenient to put it in the Kinderhook. North of the Ozarks the Mississippian is rich in limestones, whereas southwards from them, in Oklahoma and Arkansas, many limestones grade into dark shale, and changing facies–faunas render correlation difficult. In Oklahoma and Kansas there is much production from the "Mississipi lime." While in Kansas and North-east Oklahoma this is white and cherty, similar to the Boone limestone and chert, of Osage and Lower Meramec age, in Central Oklahoma it becomes a black, gritty, argillaceous limestone, called "Mayes" by those who correlate it with only the Meramec division of the Mississippian. The Boone itself, in the Tri-State zinc and lead-mining district, of Missouri, Kansas, and Oklahoma, contains numerous seeps of asphaltic oil. Meramec beds in North-west Oklahoma and South-west Kansas have been explored in recent years, and are now yielding oil in Scott County, Kansas, for which State a detailed microscopic study of the Mississippian has been published. The richly limy facies is also well developed underneath the Pennsylvanian over most of Nebraska, Iowa, and Missouri, except on the tops of major structural features like the Cambridge anticline and Nemaha ridge.

Pennsylvanian strata, striking, on the average, a little east of north, are exposed from North-central Iowa to the Llano uplift. In Oklahoma and Kansas the sequence is specially thick and complete. It may be divided into Morrow, Des Moines, Missouri, and Virgil, each of which succeeds an unconformity. During or just after Morrow time the following structures were rejuvenated or originated—Llano uplift, Concho arch, Red River uplift, in Texas; Criner Hills, Hunton-Tishomingo uplift, initiation of Ardmore basin, probably of Arbuckle anticline, and Central Oklahoma uplift, in Oklahoma; Wichita–Amarillo Mountains, in Oklahoma and Texas; Nemaha ridge and Central Kansas uplift, in Kansas; and many oil-producing structures. In the basins into which the area was divided, the Des Moines sediments were laid down. The unconformity between the Missouri and Virgil seems to mark the early period of orogeny in the Ouachita–Marathon range, the margin of overthrusting lying to south and east of the Llano foreland. Contemporaneously the western Arbuckle Mountains anticline and the Ardmore basin were accentuated, and there was growth of the Arbuckle, Wichita, and Amarillo Mountains. The Morrow, in which Cromwell sand and "Wapanucka lime" are notable yielders, and the Des Moines, only a little wider in distribution and containing the Booch, Bartlesville-Glenn, Burbank, Prue-Calvin, and Oswego and Big lime horizons, are present in Texas, Oklahoma, and Arkansas, whilst the Missouri and Virgil occur, unless removed by recent erosion, throughout the Pennsylvanian outcrop and underground to west of it. The principal producers in North Texas, South and South-east Oklahoma, North-west Arkansas, and West Missouri, belong to the Pennsylvanian. In Northern Texas a new Lampasas "Series" has been proposed, between the Morrow and Des Moines. It includes famous pay-zones of the so-called "Caddo Lime" and also deeper pays in coarse sand in Montague County. The Texan upper part of the Des Moines is the Strawn which covers most of the earlier Carboniferous structural developments with the exception of the Amarillo uplift. The K.M.A. and Hull–Silk fields of Wichita and Archer Counties yield mostly from sandstones in the Strawn. Canyon (Missouri) and Cisco (Virgil) Series are also productive.

Between the Virgil with its red beds and the Permain System above it, the transition is a gradual one. The Permian of South-west Texas includes the Wolfcamp, Leonard, Guadalupe, and Ochoa Series, identified mainly by marine fossils. In North Texas and Oklahoma the section comprises a great thickness of red beds with gypsum and salt basins and deltaic fans of sandstone. These and other localised phenomena, like arkosic washes from the Arbuckle Mountains and even, in one place, a calcareous and dolomitic sand interpreted as an offshore bar, do not lend themselves to lateral correlation, but both to north and south there is interdigitation of marine beds, so that marine equivalents can be surmised. Subterranean Permian is ubiquitous west of the outcrop, and in West Texas there is a buried, deep basin of several thousand

feet of, in descending order, salt, anhydrite, dolomite, and limestone. The chief salt bed in Kansas and Texas rises in the stratigraphical column as it is traced to the south-west, but beneath it the general sequence is maintained, oil being found in the anhydrite, dolomite, and limestone, and in intercalated sands. In the Texas panhandle, the anhydrite and underlying dolomite are lumped together as the "Panhandle big lime." In Oklahoma Permian gas becomes important, and in the Oklahoma panhandle and Hugoton field, Kansas, mostly gas is yielded.

In the western parts of Texas, Oklahoma, and Kansas, the Trias, represented by the upper Triassic Dockum, composed entirely of non-marine red-beds famous for vertebrate fossils, including phytosaurs, overlies the Permian with probable unconformity. It is overlain unconformably by the Jurassic, but also by Cretaceous on the margin of the High Plains, and by Tertiary in the Texas panhandle. The Jurassic is terrestrial with deinosaurs. 2000 ft. of salt and red beds in the sub-surface in Ouachita County, Arkansas, have recently been assigned to it by Imlay. They thicken southward in Louisiana into a marine suite of 7000 ft.

In North-west Louisiana and Arkansas, Comanche strata (Lower Cretaceous) produce oil and gas in several fields. In Marshall County, Oklahoma, the same formation yields from shallow wells in the so-called "Arbuckle" sand in the Trinity Group, and in Central Texas there is a good deal of oil obtained from the Fredricksburg Group which succeeds the Trinity. The Gulf Series (Upper Cretaceous) rests with unconformity on the Comanche, and the Woodbine sand at its base is the chief producer in the Mexia fault zone and Van pool, in North-east Texas and in the eastern Texas field. Yields are also obtained from higher horizons—Blossom-Tokio (Austin Group), Buckrange and Ozan (Taylor), and the Nacatoch (Navarro) sands in North-east Texas and adjacent parts of Arkansas and Louisiana. Cretaceous oil production is thus restricted to the southern Mid-Continent, though in the north, in Nebraska, Iowa, and Kansas, the Dakota sandstone forms the base of the Upper Cretaceous. A. L.

133.* Amount of Source Bed Required to Furnish Oklahoma City Oil Pool. R. L. Ginter. *Bull. Amer. Ass. Petrol. Geol.*, September 1941, **25** (9), 1706–1712.—The Cherokee shale is used as a hypothetical sole source for the Oklahoma City oil reserve of 600 million brl. The Cherokee was laid down on porous, permeable, pre-Pennsylvanian rocks, entirely burying a land-surface of Mississippian down to Arbuckle beds. When the overburden was supplied, the resulting compaction of the shale presumably moved the primordial crude oil into the porous beds under the unconformity. The oil would then migrate upward through the top beds of this old land-surface and probably laterally across the beds near the top of the structure, the porosity features being sufficiently large to provide for gravity separation of oil and water. Originally the pool probably had a common water-table, and contrary evidence seems to be due to unequal rates of withdrawals.

By using certain assumptions about the original organic content of the source sediment (taken as 35%), proportion of organic matter converted to crude oil (4·5% suggested), percentage of generated oil lost during migration (estimated at 50%), percentage of shale compaction (taken at 60%), and a reasonable figure for the original amount of oil in the oil-pool; the distance of migration to the Oklahoma City reservoir is calculated to be no more than 7·86 miles and the volume of mother shales to be 3·5 cu. miles. J. T.

134.* Peru—Production Continues Decline, Refining Slumps. Anon. *Oil Gas J.*, 13.11.41, **40** (27), 26.—During the first half of 1941, Peru's crude output was 5,419,162 brl. against 6,078,481 brl. in the same period of 1940. The natural gasoline production was 475,946 brl.

A table lists the output of various products during the first half of 1940 and of 1941. G. D. H.

135.* Venezuela—Discovery of New Field Likely at Ultramar Test. Anon. *Oil Gas J.*, 13.11.41, **40** (27), 26.—2 Mercedes in the State of Guarico has penetrated the uppermost series of oil-sands at a depth of 4358 ft. Drill-stem tests are reported to have been made, and the top of the sand is said to have been proved gas-bearing. The

second sand yielded 30° Be oil. The area lies about 90 ml. west of the newly opened Ollas area, and 125 ml. west of the El Roble field.

In the San Joaquin field of Anzoategui, 3 Guario is coring below 10,768 ft., and 4 Guario is fishing at 6843 ft. 1 Anaco, in the El Roble district, is testing at 11,294 ft.

During August the Standard of Venezuela completed four wells at Jusepin at an average depth of 4537 ft. and for an average output of 605 brl. each/day. Two wells were completed at Oficina for 470 brl. each, and one at Leona for 688 brl./day at 7750 ft. G. D. H.

136.* **Major-field Need Demands Outpost-Area Exploration.** W. V. Howard. *Oil Gas J.*, 11.12.41, **40** (31), 30.—An increase in price of oil encourages wildcatting, and drilling proceeds in areas where a high yield is not expected. Discoveries in such areas do not greatly increase the reserves. Exploration may be based on previously defined concepts regarding oil-accumulation sites, or after a random discovery there may be an intensive search for similar fields.

The chances of major discoveries are less in the older areas than in the newer areas. The most spectacular successes of the past seem to have come by combining known conditions in one or more sections and trying to find them in a nearby area, but the record of development in areas which start with rank wildcats is usually very spotty. G. D. H.

137.* **Increased Exploration Required by Declining Discovery Rate.** W. V. Howard. *Oil Gas J.*, 27.11.41, **40** (29), 26.—Estimates of discoveries of oil reserves fall into two classes—namely, those found in the early development of fields, and those found in the same fields at some later date. It appears that the amount credited to fields during the first year averages 40–60% of the total which will eventually be allocated to those fields in the first period of development.

Reserves are added to old fields mainly by reason of the discovery of deeper pays, and it is impossible to predict the date at which deeper development will take place. In a normal year about 3% of the total reserve comes from additions to old fields.

Early estimates are generally conservative, and in most cases the revision is upwards, and this may constitute 4% of the total reserves annually.

The discovery rate is unpredictable as far as additions to reserves are concerned.

Reserves may be appraised in terms of years' supply, and so show if the rate of discovery is likely to meet future requirements, although it is realized that in most instances the oil could not be produced in the time set out. The optimum reserve, the balance between shortage and unsettling flush production, appears to be approximately thirteen times the current annual production.

Although there is no immediate danger of shortage, provided no sharp increase in consumption occurs, the reserves added in the past two years through new fields is insufficient to meet the immediate needs for flush production.

Tables present data on the allocation of the new oil found and on the discovery requirements in the period 1935–41. G. D. H.

138.* **Venezuela—Standard and Lago Complete Seven Wells—One Gas, Six Oil.** Anon. *Oil Gas J.*, 4.12.41, **40** (30), 24.—In the Mulata area, a gas-well was completed at 1,200,000 cu. ft./day from 4100 ft. Four oil-wells in the Tia Juana area had an average initial output of 1094 brl./day from 3600 ft., one at Jusepin gave 100 brl. initially, and that at Lagumillas 470 brl./day. G. D. H.

139.* **Well Logs and Field Data of Active Oil Areas—Western and Central Kansas.** Anon. *Oil Gas J.*, 4.12.41, **40** (30), 48b.—The dominant feature of Western Kansas is the Barton arch, on the flanks of which many of the pre-Middle Pennsylvanian beds thin. In the Lower Permian the area formed part of the great Permian basin running into Texas, and in it salt and gypsum were laid down.

The oil and gas are largely associated with unconformities. In the periods when the granite was exposed, basal conglomerates and sandstones were formed, especially in the Cambrian and Lower Pennsylvanian, and both these basal formations are productive. The productive "Misener" sand below the Mississippian shales is also a basal sand.

The bulk of the Western Kansas production is along the Barton arch, and occurs in three main areas where cross-trends traverse the arch. These cross-trends may extend into the basin to the south-west. It is possible that oil may be found in eroded limestones below unconformities, and, indeed, oil is found in the Arbuckle on the crest of the arch beneath the Pennsylvanian. The Viola produces on the south flank.

A map and series of well logs are included. G. D. H.

140. Résumé of Oil-field Operations in 1938. R. D. Bush. *California Oil-fields, Summary of Operations*, Vol. 24, No. 3, 1939.—A *résumé* of California oil-field operations in 1938 has recently been published, wherein it is shown that the total production of oil for that year was 249·4 million brl., an increase of 11·9 million brl. over 1937. Estimated closed-in production was increased during 1938 from 172,507 brl. in January to 204,850 brl. in December. Total crude and refined petroleum in storage in Pacific Coast territory by the end of 1938 was 158·9 million brl., representing an increase in storage of 30·8 million brl., as against a decrease of 3·3 million brl. registered for 1937. Total crude and refined oil shipped to Atlantic Coast ports during 1938 was 4·8 million brl., or nearly ½ million brl. less than 1937 shipments. Four new oil-fields were discovered in the year under review: East Coalinga Extension, Fresno County; Wasco and Canfield Ranch, Kern County; Aliso Canyon, Los Angeles County. New productive areas were developed at Wilmington, Torrance, Rosecrans, Dominguez, Huntington Beach Tidelands, all Los Angeles County; at Coles Levee, Ten Section, Round Mountain, Kern County; also at Rio Vista Gas field, Solano and Sacramento Counties. Finally, deeper oil producing zones were penetrated in Montebello field, Los Angeles County, and in Greeley field, Kern County. Details of all these operations are given. H. B. M.

Drilling

141.* Drill-Pipe and Tool-Joint Troubles—Their Causes and Prevention. Part II. R. S. Grant and H. G. Texter. *Oil Gas J.*, 13.11.41, **40** (27), 50. *Paper Presented Before American Petroleum Institute.*—Fatigue and corrosion are studied in detail. The whole vicious circle of corrosion fatigue might be thought of as follows: (1) The chemical effects produce a minute pit. The electro-galvanic effect between scale, steel, and fluid produces another pit, or deepens the first one. (2) Then, as the pipe metal is bent, or stretched, the stress is concentrated at the bottom of the pit, just as at the bottom of a notch. This creates a difference in potential between the highly stressed bottom and the unstressed edges of the pit, and an electric current is set up which further deepens the pit. (3) Then, in a deeper pit the stress concentration increases still further, the electro-potential difference is greater, and the current becomes more effective in making the pit still deeper, and so on. Small wonder, then, that corrosion plus fatigue can so greatly reduce the life of drill-pipe, as compared with what either factor alone could do.

So far there is no accepted method for preventing corrosion fatigue—although, as stated, practical study of the problem currently is being undertaken. Removing scale from the inside wall might be the first step, but is probably only a short step. The real solution would seem to be coating the inside of the pipe so as to entirely prevent corrosion. However, the problem of finding a coating which could be readily applied, without pin-holes, absolutely impervious to all drilling fluids ordinarily encountered, and with sufficient ductility to withstand tension, bending, hammering, and erosion by the mud stream, is not an easy task. The same problem has long been studied on sucker rods, with none too great success. Alloy steels have proved disappointing. Chemical treatment is still in the experimental stage.

The paper deals with a large variety of troubles, including hydrogen sulphide embrittlement, eccentric wear on pipes and tool-joint troubles. A. H. N.

142.* Better Pulling Methods Permit Greater Recovery of Casing. O. H. Stormont. *Oil Gas J.*, 27.11.41, **40** (29), 54.—With the use of modern pulling equipment and improved methods of recovery, it is now not uncommon to obtain 100% of the casing from wells more than 4000 ft. deep. In shallower wells casing-shoes were being

pulled with monotonous regularity, and in one 4700-ft. well 100% of the casing was recovered.

After the pulling machine is placed over the well and guyed down, the hydraulic jacks are set up. They are connected to the pump by fitted lengths of pipe and hammer-type unions. The jacks are linked together with two steel arched bars, and upper and lower spiders equipped with sub-rings to fit standard A.P.I. slips. It is highly important that the jack foundation be level and the spiders be centred, in order to place a straight pull on the casing. A short piece of casing is run through the spiders and, by use of a swedge, if necessary, screwed on to the casing-string. The slips are then placed, and pulling is ready to start.

In loosening the pipe the amount of pull placed on the casing is largely governed by the length of the string and the age and weight of the casing. In a 1650-ft. well 15 or 20 years old, and equipped with 20-lb. lap-weld casing, a maximum pull of 85,000–90,000 lb./sq. in. is exerted. If 22 lb., eight round-thread seamless casing is being pulled, maximum strain of 175,000–250,000 lb. will usually not endanger the pipe.

The pressure is applied slowly until the maximum estimated safe pull is reached; the jacks are then lowered. This intermittent application and removal of tension tends to free the pipe from the surrounding formations and makes for greater recovery. It is continued until the amount of "stretch" obtained remains fairly constant at maximum safe load. When this point is reached, the contractor is able to estimate the amount of pipe that will be recovered.

Experience has shown that in pulling old 20-lb. lap-weld casing, a stretch of $\frac{3}{4}$ in. indicates 100 ft. of casing recovery. In newer 22-lb. seamless casing each 100 ft. of recovery is indicated by 1–1$\frac{1}{4}$ in. of stretch. Thus in a 1600-ft. well equipped with 20-lb. lap-weld casing, if an 11-in. stretch was obtained it would indicate that recovery of about 1500 ft. might be expected.

To recover the casing a small shot of solidified nitroglycerin is run in on a wire line. It is spotted at the first collar above the depth to which the casing is expected to be recovered. This is done by means of "feelers" placed on the wire line with the shot. The feelers are expanded when they reach the correct depth and then pulled up a few feet until they strike the first collar. The shot is then fired by dropping a weight, or by any of several other common methods.

The use of mud and of olive oil to increase recovery is briefly discussed.

A. H. N.

143.* Methods of Determining Value of Native Clays Used as Drilling Muds. V. B. Zacher. *Oil Gas J.*, 27.11.41, **40** (29), 60. *Paper Presented Before American Petroleum Institute.*—The author suggests the use of a "merit index" for muds which combines the results of different significant tests. These are: (*a*) for average or heavy muds; Index $= \left(\frac{1000W}{LTR}\right)$, where W = mud weight (lb./cu. ft.) at 30 sec. visc.; L = water loss (c.c.) at 78 lb./cu. ft., 185° F.; T = cake (mm.) at 78 lb./cu. ft., 185° F.; R = reaction to T.S.P.P. (from 30 sec. visc. at 1 lb./brl. or 1·7 g./600 c.c.); (*b*) for light or colloidal muds, Index $= \left(\frac{1000Y}{LTR}\right)$, where Y = yield brl./ton. at 30 sec. visc., $\frac{222}{W - 62{\cdot}4}$, W at 30 sec. visc.; L = water loss (c.c.) 30 sec. visc., 185° F.; T = cake (mm.) 30 sec. visc., 185° F.; R = reaction to T.S.P.P. (from 30 sec. visc. at 1 lb./brl. or 1·7 gm./600 c.c.).

It is specified that (1) all clays are thoroughly bunged and mixed in a gear-pump or equivalent mixer; (2) all viscosities are read at 500 c.c. in, 500 c.c. out, using a $\frac{1}{8}$-in. orifice; (3) all filter tests are taken at 100 lb./sq. in. from zero to 15 min. using a 3-in. diameter cell.

The tests are briefly discussed.

A. H. N.

144.* Reverse Circulation Speeds Completions at Cromwell. H. F. Simons. *Oil Gas J.*, 4.12.41, **40** (30), 34.—Reverse circulation of the drilling fluid is obtained by installing a pack-off head capable of rotation on the casing string, and then directing the flow of mud down the annulus and up through the tubing to which the bit is

attached. The purpose of the reverse-circulation method is to obtain a better completion at less cost. Debris and mud-cake on the producing zone can be removed from the hole by circulating oil and a normal well completed in 24–36 hr. after moving in. Where a well is shot it requires 3–5 days to drill in, shoot, clean out after the shot, and give the well a production test. The completion of small holes with cable-tools is tedious and often produces complications which add to the time and expense. Use of the reverse circulator results in substantial savings over both slim-hole and regular-hole cable-tool completions. Contamination of the sand is avoided if mud and water are eliminated during completion. Use of oil and ordinary circulation have not been successful because of the high fluid velocity required for such a light fluid to remove cuttings from the hole. By reversing circulation and pumping oil down the annular space and up through the drill-stem, a very high velocity prevails during the trip to the surface.

The increase in velocity of the upward stream is proportional to the area of the annulus and tubing. Where normal circulation gives a velocity of 125 ft./sec. in the annulus formed by 2-in. tubing inside 4½-in. casing, reversing circulation will give approximately four times that velocity in the tubing. Actual fluid velocity with one 4½- by 6-in. pump operating at 60 s.p.m. is 500 ft./min. through the tubing. As the carrying power of a stream is a geometric function to its velocity, this increase has a great effect on the size and density of particles which can be brought to the surface. Even large pieces of steel can be removed from the hole. In one case a reverse-circulating crew recovered a set of steel bearings which had been lost in the hole when a cutter element came off a rock-bit. Time for cuttings to come to the surface from 4500 ft. is less than 10 min.

Details are given of the whole operation.

The reverse-circulation method has been tried for cleaning out old wells, but where the formation pressure is low it is not yet entirely successful, because of the difficulty in maintaining circulation. On new completions, little, if any, oil escapes into the pay-zone, and it can be recovered. On old wells the loss is substantial, and the main objective—removing accumulated debris—is not realized. A number of plugging agents have been employed, the most successful of which is flake mica. There is, however, some question about reopening of sand-pores after they have been deliberately plugged. Reverse circulators are consistently used only on new wells or old ones which still have appreciable bottom-hole pressure. A. H. N.

145.* Field Transportation and Especially Developed Equipment. S. H. Grinnell. *Oil Wkly*, 10.11.41, **103** (10), 33–34. *Paper Presented Before American Petroleum Institute.*—The equipment discussed are divided into two classes: (1) portable equipment defined as "that equipment which is moved daily on the highways, and which conforms to all state, county and city laws"; (2) mobile equipment, defined as "that equipment which is moved every two or three weeks, and which does not necessarily conform to any laws and requires permits if moved on the highways." Practically all drilling equipment is of the mobile type and, when moved from one geographical location to another in the State, it is so designed that it can be broken down in size and be readily moved by trucks or shipped by rail. When in use in any area, the smaller shipping units are assembled in a master unit which is generally "overweight," "over-height," and "over-width," thereby necessitating permits, and it must be moved on special transportation equipment.

As an illustration, moving derricks in California is discussed in detail. Moving is accomplished either by putting track-laying wheels or rubber-tyred dollies under the derrick and towing by tractor or truck. There is a steel I-beam protruding from two corners of the derrick; the derrick is jacked-up and the track-laying wheels are slipped on—the protruding I-beams being used as axles. Directly opposite these two wheels is placed a steel I-beam equivalent to 12 in. on top of the steel foundation, making a total of 24 in. of 79-lb. steel to give additional support; a sway-backed dolly made of track-laying wheels is placed under the centre of this I-beam. The advantage of three-point suspension is that, at all times, there are three points of contact with the ground, whereas with four-point suspension there is a possibility of high spots on the two diagonal corners which would cause rocking of the derrick, and also the possibility of an undue strain on members of the derrick. When the derrick is moved, some operators hang a plumb-bob from the centre of the

derrick at the water-table; so long as this plumb-bob hangs free within the derrick, the centre of gravity is such that there is no danger of upsetting.

Other items discussed include the cost of moving various equipment. A. H. N.

146.* **Drilling Activity is Maintained at High Level.** Anon. *Oil Wkly*, 10.11.41, **103** (10), 55.—Although a number of factors have been conducive to a reduction in drilling, the completions for October and the number of rigs drilling on 1st November show no slowing down in drilling for the country as a whole. The average for October was 102 completions/day, against 102·2/day for September and 82·4/day in October 1940.

Tables give the completions by states in October 1940, and September and October 1941, the type of well and the initial production, the cumulative completions for the first ten months of 1940 and 1941, the total rigs in operation on 1st November, 1940, 1st October and 1st November, 1941, with details of the field activity on 1st November, 1941. G. D. H.

147.* **Co-ordination and Planning Reduce Drilling Time.** G. M. Wilson. *Oil Wkly*, 1.12.41, **103** (13), 15–17.—An average total of from 7 to 10 days/well from spudding to pumping into the tanks has been maintained in a string of wells, averaging between 3100 and 3500 ft. deep, recently completed in the Wilmington field of California. Despite the fast time, no special equipment was used; in fact, some of the drilling conditions were far from ideal, as compared with those usually encountered in other fields.

Credit for this accomplishment is largely due to at least two very important factors: (1) unusually thorough planning of all phases of the drilling of each well before a bit was spudded, and (2) perfect co-ordination between the men and equipment, as well as between the management and the facilities of the supply and well-servicing companies.

The wells were drilled along a 21-ft. strip of property, flanked by a railroad right-of-way on one side and by a river flood-control channel on the other. Details of drilling and completing operations are given. These details show the way time was saved by planning operations such as well conditioning, cementing, etc.

The efficient development of this particular 9-well lease was directly reflected in the relatively low drilling costs. The total prorated cost of each well was only approximately $20,000. This figure includes all drilling costs, casing, tubing, rods, pumping units, and all fittings. This cost compared with the somewhat higher figure of $35,000–$40,000, which is considered to be the approximate average in this field for drilling under similar conditions. Labour and prorated salaries for each well average only $2100. A. H. N.

148.* **Design of Casing Strings. Part 1.** E. N. Kemler. *Oil Wkly*, 1.12.41, **103** (13), 20).—This is the first of a series of papers intended to give an exhaustive analysis of the problems met in casing design. In this part the subjects discussed are external or collapsing pressures, internal or bursting pressures, tensile loading, and buckling loads. The paper is well illustrated by charts giving pressures of different types *versus* depth.

When casing is first installed and cemented in a well, it is subjected to the pressure from the fluid in the producing formation on the inside, and the pressure from the mud in which it was run or the pressure from any porous fluid-bearing formations on the outside. Since these two pressures for a new well under static conditions are practically equal if the internal fluid is a liquid, the casing is subjected to very little load from this source. If, however, the well is bailed down so that there is no pressure on the inside, then the external pressure gives the load, which is called the collapsing pressure. Also as the well is depleted, and if the producing formation pressure decreases to a relatively low value, the casing will then be subjected to the unbalanced external or collapsing pressure. This presure can be calculated from the equation, $p = 0{\cdot}433sl = 0{\cdot}00694p_m l = 0{\cdot}052W_m l$, where l = well depth in ft., s = specific gravity of fluid, p_m = mud weight in lb./ft.^{3}, W_m = mud weight in lb./gal., p = pressure due to mud column in lb./in.^{2}

Internal pressures may exceed the safety limits in such cases as squeeze cementing

or where gas or distillate pressure at the top of the casing is excessively high and unbalanced by external pressure, and will result in a burst. When casing is full of liquid and closed at the top, the thermal expansion of the liquid may also result in excessive internal pressure.

When casing is being run in a well to the required depth it is subject to an axial load resulting from its weight. During this process the weight to be carried under static conditions will be equal to the casing weight less the buoyant effect of the mud in which it is run. If the casing is run open-ended this buoyant effect will be equal to the difference in density of the steel and of the mud, multiplied by the volume of the steel. This can be expressed in equation form as, $L_w = lw\left(l - \frac{Pm}{Ps}\right)$, where L_w = total tensile load on the casing due to its weight, l = length of casing suspended, w = weight of casing/ft. in air, Ps = density of steel = 0·2833 lb./in.³, Pm = density of drilling mud = 0·03613 × specific gravity of mud = lb./in.³

When the casing is cemented a change in temperature results in a change in tensile loading, due to expansion and contraction. The change of load is $L_t = a\Delta tAE$, where L_t = increase or decrease in load due to temperature decrease or increase, a = coefficient of expansion of steel 6·9 × 10^{-6}, t = change in temperature in degrees F., a = area of pipe in in.², E = modulus of elasticity of steel = 30 × 10^6 lb./in.²

Poisson's effect is studied, and is given by $Lp = S_e A\sigma$, where Lp = change in load due to tangented stress, S_e = tangential stress due to internal or external pressure, A = area of pipe in square inches, σ = Poisson's ratio = 0·26 for steel.

S_e is given by $S_e = \frac{PD}{2t}$, where P is the internal pressure in lb./in.²; D is pipe diameter in inches; t is wall thickness of pipe in inches.

Buckling loads are given by the usual Euler's equation $Lc = \frac{\pi^2 EI}{l^2}$, where $I = \frac{\pi}{64}(D_1^4 - D_2^4)$. A. H. N.

149.* New Methods Tame Wild Gas Well. Anon. *Oil Wkly*, 1.12.41, **103** (13), 44.—Unusual methods, believed to be tried for the first time, were recently used to control a wild well near Chickasha, Oklahoma. Casing was set through water and gas sands and cemented—all done while the well was blowing an estimated 40 million cu. ft. of gas daily from 3800 ft. and in danger of cratering.

The well had 151 ft. of 10-in. surface pipe cemented, and at top of the casing 12 ft. of 10-in. flow-line with no connections were welded. Below the bottom of the surface pipe were a number of water-sands, and below these, at approximately 2400 ft., were several depleted gas-sands. Drilling had progressed to 3800 ft. when a stray sand was encountered.

Operators started to pull the drill-pipe out of the hole in order to put on a blow-out preventer, but before this could be done the well blew out. Acting quickly, the kelly was put back on in an attempt to kill the flow. This plan not being successful, and in order that more mud could be pumped in the hole, the drill-pipe was shot at 3400 ft. Added volume from mud-hogs killed the flow. As there was no gate at the top, the well again blew out. Thus it was necessary to plug the well, shoot the drill-pipe at different points, and cement a casing string. The operations are given in detail. A. H. N.

150.* Portable Cooling Tower Improves Rotary Mud Properties. G. M. Wilson. *Oil Wkly*, 8.12.41, **104** (1), 30.—By cooling the mud on wells 8000–10,000 ft. in depth in California improved mud-pump operation, more satisfactory viscosity control, a thinner mud-sheath, and a greatly reduced filter loss are obtained. Mud temperature, which, without the cooler, would ordinarily range between 135° and 145° F. at these depths, is now being lowered to and held at between 110° and 115°, through the use of a skid-mounted portable cooling tower, which in most outward appearances closely resembles an ordinary water-cooling tower. The mud is, however, circulated through a closed system of small piping which is cooled by a combination of water spray falling from an overhead sprinkling system, together with a forced draught created by a 4-ft. propeller-type fan mounted in a metal hood in one end of the tower.

A small steam engine supplies the economical power which drives the fan and centrifugal water-circulating pump. Details of the cooling tower are given.

An important result was found from a 1-hr. test, which showed that cake-thickness was reduced from $\frac{1}{4}$ in. to $\frac{1}{16}$ in. Approximately 27% reduction in filter loss, based on the 1-hr. test, is therefore possible by cooling the mud from 140° to 105°. A thinner sheath was also noted.

A later field test was made which further substantiated this percentage figure. On two similar wells with like conditions at approximately 8000 ft., the fluid loss in the suction pit was measured for a ½-hr. period by shutting off water and chemical in the ditch at each well. With a flow-line temperature of 138° in Well *A*, the fluid loss in ½-hr. was 2¾ brl. With a flow-line temperature of 110° in Well *B*, the fluid loss in ½-hr. was only 2 brl. This represents a saving of approximately 25% in the fluid loss caused by the higher mud temperatures encountered at depth.

The operation of the mud-pumps has also been measurably improved. The temperatures have been lowered to points which correspond to the specifications recommended by the manufacturers of the rubber sleeves, which ordinarily is less than 120°. As a result, pump-strokes are smoother, and a much higher pumping efficiency is being obtained.

The lowering of mud temperatures directly affects the problem of properly controlling the viscosity of the mud by means of chemicals. It was found that through the use of a cooler, such chemical treatments were rendered much more effective.

A. H. N.

151.* Design of Casing Strings. Part II. E. N. Kemler. *Oil Wkly*, 8.12.41, **104** (1), 36.—When a tube or string of casing is subjected to external pressure it will, up to a certain pressure, contract uniformly as the pressure is increased, like any elastic body under stable equilibrium conditions. For higher pressures, the tube becomes unstable and failure results because of buckling of the tube. The method of failure is similar to that of a slender rod subjected to an axial load. If a slender rod is loaded axially it will, up to a certain load, deflect proportionally to the load. When the load reaches a certain critical value, the rod will buckle, and failure will occur without warning. The rigorous mathematical treatment of failure of a tube subject to external pressure for all conditions is very difficult and involved.

The equation for determining the load at which failure due to instability will result is often called the elastic curve. The basis of the elastic curve given by the A.P.I. is the formula $P = \frac{62{\cdot}6 \times 10^6}{D/t(D/t - \frac{1}{3})^2}$, where P = pressure at which collapse will occur in lb./in.^{2}, D = pipe diameter in inches, t = pipe-wall thickness in inches.

A discussion of this curve is given, together with other equations as given by different workers.

The strength of joints in tension is becoming increasingly important as deeper wells are drilled. By working on electrically welded joints it was found that the joint strength in tension was, within experimental limits, a function of the yield strength of the material in tension, and generally independent of the ultimate strength of the material. The curves of load *vs.* wall thickness were essentially straight lines which intersected the zero load line at a wall thickness of from 0·070 to 0·080 in. This range represents the wall thickness used by the threads, or the thickness at which no metal would be left under the roots of the threads.

For failure by bursting pressure the recommended form is more conservative than the one generally used. It is given as $P = \frac{2 \times 0{\cdot}875 S_y t}{D}$, where P = bursting pressure in lb./sq. in., S_y = the minimum yield strength in tension, in lb./sq. in., t = nominal wall thickness in in., and D = outside diameter in in.

As a result of certain studies minimum values for casing strengths and criteria were set. The minimum collapse strength was set at 75% of the average collapse pressure as given in present A.P.I. Bulletin 5-c-2. Minimum joint-strength values were set at 80% of the average ultimate strength values as now given in Bulletin 5-c-2. The minimum bursting strength was made 87½% of the values now given in Bulletin 5-c-2. These values are tentative and are necessarily subjected to revision as more data and information becomes available.

A. H. N.

152.* Completions Under Month Ago but Above Year Ago. Anon. *Oil Wkly*, 8.12.41, **104** (1), 45.—In November the U.S.A. completions averaged 97·6/day, against 101·3/day in October and 102·2/day in September. Drilling was curtailed in November in Oklahoma, Kansas, North Texas, West Texas, New Mexico, North Louisiana, and Mississippi, but in other districts there was little change.

At the beginning of December 1941, 4746 rigs were in operation.

Tables give by states the completions in November 1940 and October and November 1941; details of the wells drilled in 1941; the cumulative completions for the first eleven months of 1940 and 1941, and details of the wells completed in 1941; the number of rigs in operation on 1st December, 1940, 1st November and 1st December 1941, and the status of the rigs. G. D. H.

153.* Automatic Release Hanger Lessens Heavy Tong Chores. Anon. *Oil Wkly*, 15.12.41, **104** (2), 30.—A simple type of hook, featuring automatic release of the tongs when required, has been worked out by one company, in which gravity is used as the actuating force to free the tongs and permit ready swinging of the tool back to engagement with the string of pipe.

The usual hanger stand is used as basis for the fastening, with a nipple of 1-in. pipe, some 4 in. in length, being welded vertically to the draw-works side of the stand, with the base of the nipple some 36 in. above the floor. Up through this nipple is slipped a 24- or 26-in. long ¾-in.-diameter steel bolt, the head engaging against the bottom of the nipple if raised to highest elevation possible. The upper portion of the bolt is heated and bent at a point some 16 or 18 in. from the head, being bent sharply through 90° to form a shoulder which will abut on the top of the vertical nipple. The outer end of the bolt is then again bent upward, to form a hook with slight slope toward the angle at its base. The hooked end is about 4 in. in length, to provide ample engagement for the eye of the back-up tongs.

To hang tongs with this hanger, they are swung back into the general direction of the support, the eye riding above the height of the hook in the bolt when the latter is in its lowest or dropped position. To engage the hook in the eye with one hand while guiding the swing of the tongs with the other is a comparatively simple operation, the bolt having a space of some 14 in. vertically through which it may be moved to engage the hook, whilst the offset permits a lateral swing through a circle with a radius of around 12 in.

Details of operations and advantages accrued are given. A. H. N.

154.* Designs of Casing Strings. Part III. E. N. Kemler. *Oil Wkly*, 15.12.41, **104** (2), 33.—This part deals with failure due to a combination of stresses studied in the first two parts. Formulæ for calculating maximum stress values engendered by a combination of various types of loadings are given and discussed.

The design of a specific string of casing involves many factors, some of which are difficult to evaluate. Fortunately most of these factors are decided by the company policy and as a result of operating practices over a long period. Because of the considerable amount of money involved, the engineer must constantly study the casing programmes, in order to be able to take advantage of any local or market conditions and changes in production practices. To-day the national emergency has introduced a further problem in supply and materials, which will require constant changing of casing programmes. The operating factors which will affect the design of casing programmes are drilling practices, producing practices, and finally future well conditions.

In areas where casing failures may occur because of corrosion, or for other reasons, it may be desirable to make provision for running an emergency string to permit continued production. If a well must be cleaned out or shot, or if liners must be pulled or run, the oil-string should be of sufficient size to permit running of necessary tools.

The producing practices or requirements are the controlling factor when future well conditions do not have to be considered. The type of pool, amount of fluid to be handled, probable loads which will be encountered and allowable production will determine initial and final tubing sizes. The requirements or restrictions for taking potentials on wells may also influence casing sizes. Since failures of sucker rods and

tubing are always possible, provision must be made for fishing and clearance allowed for fishing tools.

The drilling practices will dictate the size of hole which can be drilled through a given string. Again company practice will dictate the size casing which it is safe to run in a given size of hole. The size may vary with the type of formation to be drilled and the amount of open-hole carried. Another factor which must be considered is availability in sizes, weights, and grades. In the designing of any casing programme, it is always possible to reduce the weight of steel required by using the calculated required weight. Practically, it is not feasible to have a wide range of weights and sizes, because of high cost of manufacturing and stocking of casing. Local conditions frequently are such as to make a new size or weight desirable.

A. H. N.

155.* Some Factors Controlling the Pumping Time of Oil-well Cements. G. R. Neighbors and S. Cromer. *Petrol. Tech.*, November 1941, A.I.M.M.E. Tech. Pub. No. 1399, 1–6.—The effects of temperature and pressure on the setting times of cement were examined in a paddle-type consistometer. The cement slurry was rapidly mixed and poured into the instrument. The pressure was raised to the required value, the temperature adjusted, and the test commenced within 2 min. of mixing the cement. Readings of time and the torque exerted were recorded at intervals until a fluidity equivalent to 100 poises was reached, at which stage the test was stopped.

The results show that increase in temperature markedly increases the rate of stiffening of the cement slurry, probably due to an accelerated rate of hydration on heating. The rate at which the cement becomes heated while it is being pumped in the well is uncertain, and many believe that it may not exceed 170° F. during placement, although in squeeze-cementing operations it seems likely that it may reach the formation temperature approximately.

The time to reach a fluidity equivalent to 100 poises was 15–25% less at 3000 lb./in.^{2} than at atmospheric pressure, a result which conforms with other experimental work.

A high water–cement ratio reduces the pumping time, but such slurries are easily contaminated, subject to sedimentation, and give a cured cement of very low strength. The cement after storage in tight metal cans for 3 months gave slurries with a longer setting time for a given concentration and temperature than when first used.

More data on temperatures attained during cementing are required, and an instrument capable of tests at pressures up to 12,000 lb./in.^{2} is needed.

G. D. H.

156.* Chemical Treatment of Bentonitic Suspensions and the Relationship to the Heaving-shale Problem. H. H. Power and C. R. Houssiere. *Petrol. Tech.*, November 1941, A.I.M.M.E. Tech. Pub. No. 1401, 1–16.—In attacking the heaving-shale problem, it is evident that a knowledge of the physical and chemical properties of the shales and how such shales are affected by the addition of chemicals is essential. Consequently, investigations were carried out on suspensions prepared from Wyoming bentonite. The effects of added electrolytes on viscosity and filtration were determined. The following points were noted for relatively low concentrations of electrolytes. In general, small amounts of added reagents (HCl, NaCl, KCl, Na_2SO_4, etc.) reduced the viscosity, while larger amounts increased it. There was a similar general effect as regards the amount of filtrate in 30 min. It was generally observed that the effective ion absorption was in the order: Na, K, H. The effects of combined 1*N*-KCl–1*N*-HCl did not correspond with those of the separate reagents. In some instances it appears that the assumption of the presence of ionic structures may furnish a partial explanation of viscosity changes when filtrate rates remain constant. Enmeshment of water apparently results from treatment with NaOH, but not with NaCl. Using salts, it appears that the reduction of viscosity is due to the number and kinds of ions present. The viscosity varies in inverse proportion to particle size. In a study of filtration characteristics, " bridging " of particles was shown to be important, and particle-size distribution rather than high viscosities apparently accounts for low filtration rates. The change of p_H is retarded as particle sizes decrease. If viscosity change is due primarily to adsorption of ions from solution, a

variation in p_H results. Thus, the degree of viscosity change is reflected in the change of p_H, except in so far as the viscosity changes are not always due to adsorption of ions alone. G. D. H.

157.* Tool Joint-Drill Pipe Connection. R. I. Gardner. *Petrol. World*, October 1941, **38** (10), 26.—This paper is written with the object of giving a qualitative rather than a quantitative analysis of the problems, advantages, and limitations of the various designs of tool-joints now available. One of the critical sections of the rotary drill-stem is the connection between the A.P.I. Standard tool-joint and the drill-pipe. Correct mating within the specifications is essential.

When making up the pipe end-joint a number of conditions must simultaneously be met. (1) The mating parts should truly be in contact at all points, to prevent any looseness while in service. Any looseness will inevitably develop a fatigue-type failure if the joint does not either unscrew or wash out beforehand. (2) Sufficient frictional resistance must be developed to prevent the joint from unscrewing while in service. (3) A leakproof seal must be developed to prevent washing out of the threads. In order to effectively seal the threads and to lubricate the mating parts, a good grade of metal-base thread lubricant is applied in a thin uniform coating over the threads of both box and pin. Interfacial contact pressures as high as 17,500 lb./sq. in. are developed between mating parts.

Although specifications for bucking-up tool-joints usually include the range of torque necessary to produce a satisfactory connection, mention is seldom made of the limiting number of turns allowable after "hand-tight." If, however, excessive amounts of lubricant are used, it is not possible to attain sufficient torque without permanently deforming the thread elements.

With the usual proportions of the pipe end-joint, the highest unit stresses are found in the inside surface of the pin-end. These are hoop-stresses, resulting from the radial compression of the pin by the box as the former is screwed into the latter. There are, of course, tensile hoop-stresses in the tool-joint, or box, but these are usually unimportant because of the relatively higher strength of the tool-joint material. When singles are put together with "regular" couplings, it becomes necessary to determine the hoop-stresses in the coupling as well as in the pipe.

If the usual joint is made up beyond the number of turns which will stress the pin-end to its yield-point in compression, the end of the pin will be permanently deformed. The originally carefully cut pitch-cone will be altered, resulting in an increased non-uniform taper. The bad effects of this will be evident on the next tool-joint made up.

Another reason why high compressive hoop-stresses are detrimental to strength at the last engaged thread is that a press fit acts much the same as an integral shoulder under rotating beam-type loading. This effect approaches that of the integral shoulder as the stress induced by the press-fit is increased.

The paper deals extensively with calculations and improvements of A.P.I. joints. A. H. N.

158.* Californian Equipment and Methods. N. A. D'Arcy, Jr. *Petrol. World*, November 1941, **38** (11), 61.—Much of the equipment described has recently been recounted in the literature, such as the comparatively new bulk-cementing method, the three-cylinder slush-pump, marine-type full-condensing boilers, steam-operated casing tongs, wall calipers used to predict volumes of gravel or cement required, heavy portable drilling units—Abstracts in the 1941 *Journal* may be consulted. The paper is extremely well illustrated.

Amongst the equipment described is an 87-ft. derrick unit complete with crown block, travelling block, draw-works, rotary machine, and internal-combustion engine, all mounted on a special sub-base to which Athey Trak wheels are permanently attached. This draw-works unit is moved over the rolling Poso Hills in perfect safety, as the centre of gravity is only approximately 16 ft. above the ground. It is said to be an interesting sight to see this unit travelling over the roughly graded roads, leaning at an extreme angle.

In addition to the derrick unit, there is a slush-pump unit with its internal-combustion prime mover mounted on another Athey wagon, which may be moved from one location to another merely by disconnecting the discharge line from the

pump and raising the suction line. When the drill-pipe is laid down at the completion of a hole, it is laid directly on a special drill-pipe transporting rack, also mounted on Athey wheels, and is ready to move when the last piece has been laid down. Even the doghouse on this unit is mobile. This unit has been moved over the Poso Hills road a distance of 2½ miles in 10 hr.

Another interesting feature is temperature control of muds. The temperature of the mud in these fileds is, of course, high, and a special mud-cooler is in operation. This cooler consists of a forced-draft cooling-tower, through which the mud is pumped. It is reported that the temperature of the mud can be reduced from a normal discharge temperature of 150° to approximately 105°.

Two interesting new instruments are also in use in the Dominguez field. The Mud Logger charts a 24-hr. graphic recording of the viscosity of the mud in centipoises and the weight of the mud. This chart provides a picture of the condition of the mud and enables the operator to detect dangerous portions of the drilling fluid. The chart will indicate the time-cycle required to circulate non-uniform mud, and this will enable the operator to add chemicals or weighting materials at the exact point most needed.

The Drillogger is another new instrument now operating at Dominguez. This instrument makes a continuous graphic record of the rate of penetration, weight on the bit, table speed, pump pressure, and rotary torque. Correlation of these five curves, together with a knowledge of the formation being drilled, enables the experienced operator to establish a more suitable drilling technique for a particular formation. Where the formation is not known, a continuous chart of the rate of penetration is of value in correlating core data and electric log information in establishing various strata. A. H. N.

159. Patents on Drilling. M. Hokauson. U.S.P. 2,262,001, 11.11.41. Appl. 21.8.39. Drill-bit for percussion drilling systems with several cutting and reaming edges.

S. Pennella. U.S.P. 2,262,041, 11.11.41. Appl. 7.1.41. Tube-cutter adapted to be inserted and rotated inside the tube to be cut.

G. A. De Vlieg. U.S.P. 2,262,099, 11.11.41. Appl. 3.3.39. Machine for sharpening rotary cutters.

E. J. Roe. U.S.P. 2,262,117, 11.11.41. Appl. 19.1.39. Well-plugging device with a pipe in sections and an expansible sleeve.

J. L. Downes. U.S.P. 2,262,171, 11.11.41. Appl. 6.7.38. Hose-coupling device to be used manually.

A. L. Stone. U.S.P. 2,262,210, 11.11.41. Appl. 25.9.39. Method of building up tubular joint members.

A. L. Stone. U.S.P. 2,262,211, 11.11.41. Appl. 18.3.40. Composite tool-joint for well-pipe.

A. L. Stone. U.S.P. 2,262,212, 11.11.41. Appl. 20.3.40. Method of making composite tool-joint members and the like.

L. F. Athy and H. R. Prescott. U.S.P. 2,262,419, 11.11.41. Appl. 9.4.38. Method of electromagnetic logging.

I. T. Minyard. U.S.P. 2,262,694, 11.11.41. Appl. 25.7.40. Cathead for drilling rigs fitted with a clutch.

A. Boynton. U.S.P. 2,263,564, 25.11.41. Appl. 22.9.38. Wrench for threadless drill-pipe.

A. Boynton. U.S.P. 2,263,566, 25.11.41. Appl. 28.11.38. Cementing device in combination with casing and liner assembly.

A. Muhlbach. U.S.P. 2,263,639, 25.11.41. Appl. 25.7.39. Retractable core-barrel.

R. H. Howard. U.S.P. 2,263,778, 25.11.41. Appl. 6.8.38. Applicator for drill-pipe protectors.

J. L. Havlick. U.S.P. 2,264,440, 2.12.41. Appl. 1.7.40. Diamond drill-bit with hollow bit-stock.

W. D. Mounce. U.S.P. 2,264,449, 2.12.41. Appl. 12.4.39. Method and apparatus for coring.

C. E. Carpenter and R. C. Lynch. U.S.P. 2,264,617, 2.12.41. Appl. 1.4.39. Diamond drill-bit.

F. J. Spang. U.S.P. 2,264,775, 2.12.41. Appl. 27.7.40. Well-casing elevator.

F. L. Le Bus. U.S.P. 2,264,913, 2.12.41. Appl. 7.2.39. Pipe fishing-tool.

D. H. Weinstein and L. H. Metzner. U.S.P. 2,265,093, 2.12.41. Appl. 8.1.38. Angle measuring device for surveying instruments.

H. G. Campbell. U.S.P. 2,265,472, 9.12.41. Appl. 14.9.40. Reamer for straightening an earth-hole.

C. A. Meek. U.S.P. 2,265,665, 9.12.41. Appl. 26.3.38. Cementing material obtained by finely grinding clinker resulting from fusion of an intimate mixture of lime and antigorite.

L. F. Athy, H. R. Prescott, and R. F. Hughes. U.S.P. 2,265,768, 9.12.41. Appl. 20.7.40. Method of logging bore holes.

J. F. Larkin. U.S.P. 2,265,773, 9.12.41. Appl. 7.6.38. Drilling mud containing bentonite, carbonates of alkaline-earth metals and volcanic ash. A. H. N.

Production

160.* Practical Application of Flow-Valve Installation Principles. J. E. Halferty. *Oil Gas J.*, 27.11.41, **40** (29), 46.—The conclusion reached in this long paper is that most of the difficulties encountered in the selection and installation of gas-lift equipment have resulted from an insufficient knowledge of the necessary technical data of the well's characteristics. There is little doubt that a complete survey of a prospective gas-lift well, strict adherence to the proved principles governing submergence, spacing, type of valve, and type of installation, test-rack data on the mechanical status of the valve, and a follow-up flowing gradient to determine the valve's operation, would eliminate a large number of unsatisfactory flow-valve installations. A high degree of satisfactory gas-lift operation is at hand for the operator who will demand that such information be accurately obtained and carefully examined before and after flow-valves are run in his wells.

The following conclusions are condensed from the body of the article and tabulated for convenience: (1) *Type of Valve.*—Differentially operated, spring-loaded with a minimum of different settings, of which a 125-lb. reopening, 150-lb. blow-down close, 150,000–175,000 cu. ft. of gas passage, double-seated type has been found satisfactory, particularly for high-fluid level wells. Typical unloading type single-seated valves are frequently run on top of a long string and intermitting-type valves are run on bottom. (2) *Submergence.*—Top valve should be placed approximately 150 ft. deeper for oil and 75 ft. deeper for water than the fluid load necessary to reopen the valve. Factors effecting submergence are: casing pressure, fluid gradient (lb./sq. in./ft. of depth), valve setting and volume of gas valve will pass. (3) *Spacing.*—Depends entirely in reopening pressure of valve and maximum weight of fluid to be lifted. For 125-lb. reopening differential pressure, space approximately eight tubing singles (31-ft. length) if water is present, and eleven tubing singles where well makes pipeline oil. Spacing too far will stymie; too close spacing will cause "interference" and inefficient operation. (4) *Depth of Bottom Valve.*—Determined by working fluid level in casing, production rate desired, and estimated decline of wells, bottom-hole pressure. Working fluid level is determined from productivity index, daily production rate, and fluid gradient. (5) *Flowing Friction.*—Conservative figure to use is 0·1 lb./sq. in./ft. in flowing water. Oil or aerated water column will have a proportionally smaller friction loss/ft. (6) *Semi-closed Installations.*—Used in small "tight"

wells with high maximum closed-in bottom-hole pressure (fluid level), or any small well with maximum bottom-hole pressure sufficiently high to elevate fluid a height above bottom flow-valve to create necessary pressure differential with respect to well's casing pressure and cause valve to reopen and operate. Tubing standing valve is not used in semi-closed installation. Perforated seating chamber above packer, and removable blank drop-valve, if used, enables operator to unload casing annulus without unseating packer if fluid should leak through valves into annulus during a shut-in period. (7) *Auxiliary Equipment Recommendations.*—Test-rack for testing new and removed flow-valves. Gas-line scrubber. Proper supply gas regulation. (8) *Payout.*—Average flow-valve installation in moderately corrosive area should pay out in one year or less, using 10 cents/brl. saving on flow-valve operation over pumping equipment, and assuming 10% depreciation and 5% interest charge on difference in initial investment cost between pumping and flow-valve installation. Daily allowable of 25 brl. is assumed. Where corrosion or sand conditions are severe, the saving/brl. using flow valves would probably be greater than 10 cents/brl. Conversely, where compression or supply gas costs are high, the saving will be correspondingly less.

A. H. N.

161.* Loco Hills Pressure-Maintenance Project Placed in Operation. D. H. Stormont. *Oil Gas J.*, 11.12.41, **40** (31), 48–49.—Pressure maintenance is being applied on a major scale by the operators in the Loco Hills field of Eddy County, New Mexico. The project is a co-operative effort which includes practically all the lease owners in the pool. The plant facilities and certain other details are given.

The Loco Hills field was discovered in January 1939, and although some drilling continues on inside leases, the productive limits have been fairly well established on all sides. Development has been one well to 40 acres. Production throughout most of the field is from a 2800-ft. pay. However, on the south-west side production is from a sand slightly lower than the main pay. Original bottom-hole pressure varied from 600 to 1000 lb., with the average estimated at 900 lb. The average reservoir pressure at first fell off rapidly, but during the past eight months, with daily oil withdrawals ranging from 6000 to 7500 brl., the decline has been about 8 lb./month. In August, when the most recent survey was run, the average pressure was about 661 lb. The average gas–oil ratio early in 1940 was about 800 : 1, but it has since increased to the present ratio of 1500 cu. ft./brl.

The field's main pay averages about 20 ft., with regional dip to the south and east. Analyses of cores have shown the pay to have a porosity of about 20%, with connate water content ranging from 15% to 25%. Under primary recovery methods it is estimated that ultimate oil yield would have been 4500 brl./acre. Under pressure maintenance, however, due to the highly favourable conditions for such operations, it is expected that ultimate recovery will be raised to 9000–10,000 brl./acre.

A. H. N.

162.* Red River Field Offers Example of Value of Repressuring. D. H. Stormont. *Oil Gas J.*, 18.12.41, **40** (32), 32.—In the Red River field of Tillman County, Oklahoma, a 270-acre repressuring project has been under way for more than 12 years. Despite natural barriers of lenticular sands and the fact that the repressured area is located in a river-bed, the project offers an excellent example of the value of repressuring. Oil production has fallen off steadily for the past 10 years, and has now reached a point where it is expected that operations will be abandoned within the next few years. Since the project is nearing depletion, it is possible to show what has actually been accomplished by repressuring.

The geology and field structure are given, together with the sand condition of the producing formation.

At the start of gas injection, vacuum of from 20 to 26 in. was being applied at the well-heads. Experience has shown that any reduction in vacuum resulted in an immediate loss in oil production. Therefore, the vacuum was removed in stages, the time between and the amount of each cut being governed by daily oil production, so that the vacuum was not entirely eliminated until almost one year after the start of repressuring. Since then reservoir pressures have slowly increased, and to-day injection pressures vary from 10 to 30 lb. A surprisingly small loss of daily production was noted when the vacuum was removed from the wells.

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A noticeable result of the vacuum removal was an increase of the gravity of the oil produced. While vacuum was being used the average oil gravity in the field was 39°, but after the vacuum had been eliminated the average gravity was 41°, with many tanks running 42°. After the input gas had built up a pressure in the sands, the gravity fell slightly, the 42° phase being eliminated. Simultaneously with the cut in vacuum and the rise in gravity of the oil, there was a distinct drop in the gasoline content of the casing-head gas taken from the wells. The history of injection operations under different conditions is given.

The present oil output of about 275 brl. daily is being produced by some seventy oil and fifteen key-injection wells, or an average of approximately 4 brl./well/day. Many of the edge wells, however, produce in the neighbourhood of only ½ brl. daily. Economic limit of the field is estimated to be approximately 100 brl./day, thus it is probable that the field will be abandoned in 3 or 4 years. Should it prove profitable to continue operations through 1946, a total oil recovery of 7,492,000 brl. will have been produced, or a yield of about 27,700 brl./acre. As ultimate recovery under primary and vacuum operations would have totalled an estimated 5,729,000 brl., the repressuring project, by the time of abandonment, will yield an additional 1,763,000 brl. of oil. A. H. N.

163.* Future of Oil Production Methods. D. R. Knowlton. *Oil Gas J.*, 18.12.41, **40** (32), 35.—Since the discovery of oil in 1859, more than a million wells have been drilled in the United States, ranging in depth from a few feet to 15,504 ft., as the deepest well ever drilled, and 13,206 ft., as the deepest well now producing.

At present there are approximately 380,000 producing wells in the United States, with the daily average production exceeding 4,000,000 brl. It is estimated that 30% of this production flows naturally from the reservoir, and 70% is pumped.

Most oil is pumped without the assistance of secondary recovery methods, such as gas injections or water-flooding. The equipment in use varies from wooden pumping-rods in the old areas to very efficient and highly engineered individual pumping units.

The author predicts that it is in the control of reservoir energy and methods of optimum utilization of production principles that the future methods will excel. Making equipment lighter than their present weights, the advancement of hydraulic pumping, the adaptation of electrical submersible pumps to small well-pumpings, and the more effective use of wide spacing are other steps in the advance of production methods.

A strong plea is made for unitization in producing oil-fields. A. H. N.

164.* Closer Association between the Production Engineer and His Operating Co-Worker. D. R. Knowlton. *Oil Wkly*, 1.12.41, **103** (13), 38. *Paper Presented Before American Petroleum Institute.*—The development of petroleum engineering as a distinct and independent profession is discussed. The principal types of administrative organizations in general use by the oil companies are briefly explained. It is stated that the effectiveness of the association between a production engineer and an operating co-worker is in some degree directly proportional to the mutual respect and confidence which exist between them. By the selection and proper development of capable men for the jobs, by definitely instructing them as to their responsibility and authority, and by requiring joint and concerted action by them, the association of the production engineer and his operating co-worker will be more harmonious, more efficient, and more profitable. A. H. N.

165.* Fluid Back Pressure Checks Sand Caving. G. B. Nicholson. *Oil Wkly*, 8.12.41, **104** (1), 15–16.—The production from the particular field discussed was hindered by presence of apparently unlimited quantities of sand bearing fine shale particles which made producing the wells almost an impossibility. Ordinary production methods resulted in frequent sanding-up, screen-washing, and clean-out jobs, which entailed considerable expense and made economic operation doubtful, and the operators resorted to artificially flowing the wells, employing methods with which they had experience in other localities.

By lifting the fluid from a high level, the operators now hold back-pressure on the

formation by means of a heavy fluid column which supports the sand. Weight of the hydrostatic head prevents the heaving or infiltration of sandy mush which formerly followed a material lowering of the fluid column.

As an abundant supply of high-pressure natural gas was not available in the Louise field, it was decided to build a compressor station to inject air into the wells for lifting the fluid. The plant has been in operation for several months, with production records tabulated since completion verifying the efficiency and economy of its performance. A small corrugated-iron building houses the compressor, which consists of a single, 2-cylinder, 2-cycle engine of 90-horse-power capacity set on concrete flooring and using lease-gas for fuel. Water for the engine is supplied by a lease water-well, which flows prolific quantities artificially lifted by air from the compressor, whilst in a nearby location a large steel storage tank is equipped with a cooling tower which maintains the water at a suitable temperature for the engine. Near the engine-house a special tank is provided for storage of natural gas should it become available in quantities adequate for gas-lift, and the engine is adapted for conversion to compress gas instead of air.

Details of the system are given. Nine wells are joined with the air-lift system, and are staggered in operating to avoid exhausting pressure supply or constantly keeping requirements at a maximum. Each month approximately 16,000 brl. of fluid are lifted, of which 6000 brl. are oil and the remainder water. In ordinary operation, about 500,000 cu. ft. of air are used daily to lift this fluid, with a calculated air-fluid ratio slightly exceeding 900 to 1. Operators regard the lifting cost represented as extremely low, and while a slight emulsion occurs due to agitation by air, treating costs amount to only ¼ cent/brl. A. H. N.

166.* Portable Pump System Handles Output of Distillate Field. E. Sterrett. *Oil Wkly*, 8.12.41, **104** (1), 26.—In the Chapel Hill distillate field the nature of the production imposes wide spacing, with the high gas–oil ratio affording relatively small daily liquid output/well. Due to this type of production and to its high gravity, usual methods of handling the output into pipe-lines are not applicable, nor advisable, on account of the possibility of high fluid loss unless continuous supervision be present to detect and guard against leakage, line-break, or shutdown of the pumping unit.

Since but one pipe-line serves the field for gathering the liquid production, pumping problems have been simplified and constant supervision assured by fitting out a portable pumping plant which, taken to the various leases in rotation, empties the lease-tanks, then moves to the next lease and repeats. Under this system only one lease can be on the line at any time, and possible overloading through the attempt to run a number of pumps simultaneously is avoided.

A duplex plunger pump, with integral gear reduction, is mounted on the rear end of a 1½-ton truck, with the fluid end extending across the normal rear member of the pump-frame and carried on a welded extension to carry a heavy bumper out behind all pump connections.

The layout and operations of various items of the equipment are described and illustrated. A. H. N.

167.* Co-operative Water Disposal Planned for East Texas. Anon. *Oil Wkly*, 15.12.41, **104** (2), 24.—The paper discusses the plans of a large co-operative programme which may solve the increasingly serious problem of how to handle the growing volume of salt water being produced in the East Texas field, by injecting it back into the producing formation, and thus also checking the decline in reservoir pressure. Not only would this be the world's largest salt water disposal system, but probably the largest co-operative operation of any kind ever undertaken in the industry's history.

At stake is an estimated 200 to 800 million brl. of oil in ultimate recovery, a threatened increase in lifting cost as declining bottom-hole pressures force additional wells on the pump, and possible elimination of legal difficulties arising from disposal of the water by means of surface evaporation pits. The volume of salt water produced in East Texas has increased steadily and rapidly during the past year, and currently the volume is in excess of 400,000 brl./day.

The financial aspect is discussed and the setting up of a company capitalized at $4,000,000 is proposed.

Investigations to determine the most desirable method of returning East Texan field salt water to the formation led to the formulation of three methods whereby this might be accomplished, each being developed in detail to cover a section of the field which was considered as representative. After dividing the field into sections, choosing as basic boundaries those established as head-right surveys, the engineering committee of the East Texas Salt Water Disposal Group selected that portion designated on their map as Section 3-A, which comprises a strip with Kilgore approximately on a median line between northern and southern boundaries, and extending from the easternmost portion of the field westward to the vicinity of the Smith County line.

Working first from close investigation of conditions as developed within this sample or typical section, recommendations were extended to cover the East Texas field, and to provide for a daily salt water volume of in excess of 400,000 brl. Between the three sets of data worked up by the engineering committee no choice was made, all three plans being submitted for such action as might be taken.

The three plans are detailed with some discussion, together with conclusions reached on the types of treating plants and gathering systems recommended.

A. H. N.

168.* Possibilities of Secondary Recovery for the Oklahoma City Wilcox Sand. D. L. Katz. *Petrol. Tech.*, November 1941, A.I.M.M.E. Tech. Pub. No. 1400, 1–22.—The Oklahoma City Wilcox sand, discovered in March 1930, has produced 394 million brl. of oil and 819,000,000,000 cu. ft. of gas up to 1st July, 1941. A pressure of 2600 lb./in.^{2} existed in early days, and there were 100,000-brl. wells, but the reservoir pressure is now substantially atmospheric and the output 75,000 brl./day of oil from 466 pumping wells. Early estimates of the crude-oil content of the Wilcox sand indicated that about 600 million brl. of oil would remain after the pumping wells ceased to produce economically.

A brief summary is given of data obtained in examining the possibilities of a secondary recovery project for the Wilcox sand. From the reservoir conditions at various dates it is concluded that the initial residual crude oil was 1072 million brl., which accords well with sand volume and porosity information. Core data from some of the newly drilled wells show the oil saturation of the gas zone to range from 1·0 to 25·9% and that of the oil zone to be 52·7–92 8%, and a possibility of 1% or even no connate water is indicated.

Displacement pressure tests on the Wilcox sand indicate that it may not be preferentially wet by the Wilcox water. The low connate water content is in accordance with this finding, and also with the lack of beneficial results from natural water-flooding. It suggests that water-drive might not recover the desired crude oil.

A gas-injection project in the south end of the Wilcox sand has given favourable results. A gas injection and unitization plan has been worked out to recover 80 million brl. more oil than is predicted from the decline curves, and the estimated production, costs, earnings, etc., under this plan are tabulated.

Legislation to authorize the unitization is still lacking.

G. D. H.

169.* Radioactivity Logging Through Casing. L. C. Beers. *Petrol. World*, November 1941, **38** (11), 95.—The instrument consists of two parts. The lower part is an ionization chamber filled with gas. γ-rays originating in the formation produce a minute current in this chamber. The strength of this tiny current is strictly proportional to the number of γ-rays passing through the chamber/second. This ionization current is tremendously magnified by the amplifier in the upper chamber, and is transmitted up the cable to the recording equipment at the surface. Here it is further amplified and transmitted to an automatic pen recorder, which registers on a paper chart the γ-ray intensity of the formations opposite the sub-surface instrument.

The paper chart is moved in synchronism with the depth of the instrument in the hole, with the result that when the sub-surface instrument is raised, a continuous depth log is traced which shows the radioactivity of the formations outside the pipe.

It is important to note that the kind of fluid in the hole, or the presence or lack of fluid in a well, has no effect on the accuracy of radioactivity logs. The radioactivity of each formation is a permanent lithological characteristic of the rock itself.

Comparison of radioactivity logs with the previously determined stratigraphy of

both cased and uncased wells has revealed a definite tendency for sands to appear on the logs as radioactive lows and for shales to be relatively high in radioactivity. Limestones are of intermediate strength. Anhydrite, coal, and salt beds are usually low in γ-ray intensity, whilst certain black marine shales and potash beds are much more radioactive than ordinary shales. In contrast to electrical logs, which show nearly all shales to have a uniform resistivity value, the radioactivity logs show the shales to have a wide range of radioactive values. This makes it possible to discern radioactive markers or zones in otherwise monotonous shale sections which can be correlated in detail by radioactivity logs.

The radioactivity of sediment rocks, as measured by this method, is not limited to the uranium–radium series alone. Penetrating γ-rays are also emitted by minerals containing thorium and actinium and their by-products. Potassium is also slightly radioactive, and is sufficiently abundant to be an important factor in differentiating strata by this method.

Radioactivity logging is compared with electrical logging.

It is concluded that these surveys have a distinct application in guiding plug-back and perforating programmes, and are capable of revealing structural features of old fields that will be useful in planning deepening programmes. The most effective method of employing radioactivity logs is to evaluate the radioactive properties of the strata in a given area by running the radioactivity log first in a key well where complete and stratigraphic information is available, and then correlating out across the area to locate the precise depths in old wells at which the horizons of interest occur. A. H. N.

170.* **What Shall Be Done about Proration. Part III.** O. W. Willcox. *World Petrol.*, November 1941, **12** (12), 44–49.—In this series of paper the proration system practised on a world-wide basis in the sugar industry is described as a model for the petroleum industry. The system is summarized: The system is made nation-wide, and takes in (as charter members) every visible primary producer and every visible processor. Both wings of the industry are separately organized, and join in creating a central association which negotiates with the public authorities on behalf of the industry, distributes the business proratably among the primary producers and the processors, keeps out unneeded newcomers, takes charge of the product from the points of origin of the raw material to the ultimate distribution points of the finished goods, and collects a legally fixed price from the consumers which is prorated back to the producers on a legally determined basis that will ensure the economic survival of all elements of the industry. It is to be remembered that the terms of the industry's charter were first democratically thrashed out in a plenary conference of the whole industry, and were presented to the Government as the considered opinion of what the industry needed, wanted, and was prepared to do. Thus the industry elected its executive committees and boards and ran under a charter virtually written by itself.

The rest of the paper deals with the advantageous results accruing from the hypothesis that such a system was adopted by the industry. The author discusses the relation of the industry with the Government and with other industries and consumers in such cases. A. H. N.

171. **Patents on Production.** H. De Groote, B. Keiser, and C. M. Blair, Jr. U.S.P. 2,262,357, 11.11.41. Appl. 27.6.40. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,262,358, 11.11.41. Appl. 27.6.40. Process for breaking petroleum emulsions.

W. T. Lietz. U.S.P. 2,262,428, 11.11.41. Appl. 21.5.38. Process for the treatment of oil- or gas-wells.

W. St. M. E. Crake. U.S.P. 2,262,490, 11.11.41. Appl. 12.11.40. Casing-head structure for supporting a constant portion of the weight of inner casing strings.

H. R. Hogaboom. U.S.P. 2,262,535, 11.11.41. Appl. 30.9.40. Counterbalance crank for rotating shaft.

M. De Groote and B. Keiser. U.S.P. 2,262,736, 11.11.41. Appl. 27.6.40. Process for breaking petroleum emulsions.

M. De Groote. U.S.P. 2,262,737, 11.11.41. Appl. 11.10.40. Composition of matter and process for preventing water-in-oil type emulsions resulting from acidization of calcareous oil-bearing strata.

M. De Groote. U.S.P. 2,262,738, 11.11.41. Appl. 11.10.40. Composition of matter and process for preventing water-in-oil type emulsions resulting from acidization of calcareous oil-bearing strata.

M. De Groote. U.S.P. 2,262,739, 11.11.41. Appl. 11.10.40. Composition of matter and process for preventing water-in-oil type emulsions resulting from acidization of calcareous oil-bearing strata.

M. De Groote. U.S.P. 2,262,740, 11.11.41. Appl. 11.10.40. Composition of matter and process for preventing water-in-oil type emulsions resulting from acidization of calcareous oil-bearing strata.

M. De Groote. U.S.P. 2,262,741, 11.11.41. Appl. 11.10.40. Composition of matter and process for preventing water-in-oil type emulsions resulting from acidization of calcareous oil-bearing strata.

M. De Groote. U.S.P. 2,262,742, 11.11.41. Appl. 11.10.40. Composition of matter and process for preventing water-in-oil type emulsions resulting from acidization of calcareous oil-bearing strata.

M. De Groote. U.S.P. 2,262,743, 11.11.41. Appl. 12.5.41. Process for breaking petroleum emulsions.

J. P. Walker. U.S.P. 2,262,744, 11.11.41. Appl. 18.2.39. Method of recovering well-fluids.

A. Boynton. U.S.P. 2,263,565, 25.11.41. Appl. 28.11.38. Flow intermitter to control discharge of fluids from well-tubing.

G. H. Williams. U.S.P. 2,263,910, 25.11.41. Appl. 11.7.38. Standing valve-puller for valves with upward projecting stems.

W. D. Mounce. U.S.P. 2,264,450, 2.12.41. Appl. 15.4.39. Gun perforator.

P. O. Webb. U.S.P. 2,264,600, 2.12.41. Appl. 22.6.39. Paraffin scraping and oil-saving device.

G. L. Monighan. U.S.P. 2,265,082, 2.12.41. Appl. 26.7.38. Breaking up water and oil emulsions.

W. F. Bettis. U.S.P. 2,265,098, 2.12.41. Appl. 28.10.39. Release for pressure bombs for oil-wells.

R. L. Chenault. U.S.P. 2,265,099, 2.12.41. Appl. 20.12.38. Apparatus for timing well-pumps and the like.

J. A. Lyne. U.S.P. 2,265,379, 9.12.41. Appl. 26.7.39. Pumping mechanism with a pair of cranks out of phase with each other.

S. W. Long. U.S.P. 2,265,660, 9.12.41. Appl. 6.12.39. Swabbing valve for use in a well having spaced production zones.

H. C. Lawton, D. A. Limerick, and A. G. Loomis. U.S.P. 2,265,759, 9.12.41. Appl. 6.6.39. Oil-well treating fluid.

W. R. Godsey. U.S.P. 2,265,835, 9.12.41. Appl. 15.4.40. Intermitter valve for admitting gas to a liquid conduit.

W. R. Godsey and W. Horn. U.S.P. 2,265,836, 9.12.41. Appl. 15.4.40. Flow-valve for gas lift apparatus.

J. S. Normand. U.S.P. 2,265,923, 9.12.41. Appl. 17.11.38. Method of treating oil- and gas-wells to increase production.

F. A. Bent and A. G. Loomis. U.S.P. 2,265,962, 9.12.41. Appl. 9.9.36. Method of treating oil- and gas-wells for sealing off water-bearing formations by means of an alcoholate of silicon.

A. H. N.

Transport and Storage

172.* Investigate Abnormal Conditions To Improve Cathodic Protection. H. White. *Oil Gas J.*, 18.9.41, **40** (19), 106.—Eight months after installing cathodic protection for a gasoline plant, the El Paso Natural Gas Co. found that in one section pipe to soil potential was zero and 200–250 mv. less negative than the rest of the plant piping. Attempts to remedy this condition by adding carbon anodes to the iron anode system already in operation failed, whilst no improvement was yielded by replacing these carbon anodes by iron anodes. Small-scale experiments were then carried out with soil from the abnormal, corrosive area and also normal soil. The abnormal soil was shown to contain unusually large quantities of soda ash and sodium sulphate, and the increase in electrical resistance to be caused by polarization. Various chemicals, known to be depolarizers, such as sodium chloride, potassium chromate, and nitric acid, were added to the soil in attempts to eliminate this over-voltage effect, and excellent results were finally obtained by adding calcium chloride around the anodes. In the field installations perforated iron pipes were used as anodes, filled with solid calcium chloride, water poured on top, and as the calcium chloride dissolved it spread into the soil surrounding the pipe. J. C.

173.* Graphic Corrosion-Leak Record Guides Pipe-line Protection. R. Wardwell. *Oil Gas J.*, 18.9.41, **40** (19), 116.—A flexible system of graphic corrosion-leak charts has been kept by the General Petroleum Corporation for 5 years and, coupled with field inspection data, supplies a basis for determining which sections of line need protection. A complete record of leaks, type, repair, cost, etc., is kept both chronologically and according to location. Location charts show insulating flanges, which are used to terminate sections under cathodic protection, and also indicate changes in soil conditions. Time charts (one of which is illustrated) are graphs of leak location plotted against time of failure. By means of these charts future leak occurrence can be anticipated to some extent and troublesome portions of line may be defined clearly. These sections are coated or otherwise protected, thus saving much expense and making it economically possible to carry out intensive work on the affected parts. The mode of protection used varies with the district and the type of the corrosive soil. J. C.

174.* Prevention of Pipe Corrosion Highly Developed Technique. S. Thayer. *Oil Gas J.*, 25.9.41, **40** (20), 60.—Recent improvements in pipe protection are divided into three groups—viz., improvement in the quality of coating compositions, replacing of hand painting by coating machinery, and cathodic protection of uncoated or poorly coated pipes.

In dealing with existent unsatisfactorily coated pipe-lines, operators have to decide whether to rebuild the corroded sections or to instal cathodic protection. The planning of new pipe-lines in unknown soils is a more complicated undertaking. To apply a good protective coating to the entire line is safe but expensive. To define the corrosive areas and treat them only means, in general, reliance on soil-resistance measurements. Occurrence of restricted areas of corrosive soil types in apparently bland soils leads to unexpected leaks, and when this occurs it is considered best to use cathodic protection for the affected parts.

The following conclusions are reached :—

1. In planning a new line do not try to define the corrosive areas too closely.
2. Use every available practical means to determine these areas.
3. Use the best protective coatings in bad areas.
4. Do not use extra wall thickness to prolong pipe-life, since steel is the poorest as well as the most expensive of coating materials.
5. Prospects for operators planning new lines are bright. J. C.

175. Temperatures of Natural-Gas Pipe-lines and Seasonal Variations of Underground Temperatures. W. M. Deaton and E. M. Frost, Jr. *U.S. Bur. Mines. Report of Investigations*, No. 3590, October 1941.—It is pointed out in this report that operating pressure in a pipe-line may be determined easily and is usually available from records

of operation, but that temperature is seldom known. Formation of gas hydrates in natural-gas pipe-lines is, however, dependent on temperature as well as on pressure and the presence of condensed water. Consequently, the Bureau of Mines, in co-operation with the American Gas Association, conducted a pipe-line–temperature survey and studied underground temperatures at depths at which pipe-lines are ordinarily buried, with a view to acquiring information of assistance to engineers in designing and operating natural-gas pipe-lines.

A 22-in. pipe-line extending from a point near Amarillo, Texas, noth-westward through Mexico into Colorado was chosen for study, also a 16-in. pipe-line extending southward from Amarillo. In making the survey two types of temperature-measuring equipment were used—recording thermometers and thermocouples—and where data on several temperatures were desired, multiple-pen or a number of single-pen thermometers were used. At the more important installations, recording thermometers fully compensated for ambient temperatures were employed.

Survey of temperature records thus compiled reveals that ground temperatures at depths of 3 ft. or over are not affected materially by the daily fluctuations in temperature, and a lag of 2 or 3 days in temperature response may be expected following an abrupt change in atmospheric temperatures. At a depth of 6 ft. or over, the ground temperature responds only to seasonal temperature variations or to extended periods of abnormal temperatures. Yearly temperature records show that the highest temperatures at depths greater than 3 ft. usually occur in September, whereas the lowest temperatures at the same depths usually occur in March.

Temperature of the pipe-lines and gas therein is essentially the same as the temperature of the ground at a depth corresponding to that of the centre of the pipe, unless there are disturbing influences, such as compressor stations, river crossings, or abrupt changes in depth of the pipe-line. H. B. M.

See also Abstract No. 179.

Crude Petroleum

176.* Density of Crude Oils Saturated with Natural Gas. M. B. Standing and D. L. Katz. *Petrol. Tech.*, November 1941, A.I.M.M.E. Tech. Pub. No. 1397, 1–7.—The densities of naturally occurring liquid hydrocarbon mixtures are important in many petroleum engineering computations, of which the calculation of the shrinkage of a sub-surface sample of crude oil as the natural gas is evolved is an example. Density data are given for fifteen saturated hydrocarbon liquids in the range 35–250° F. and 1000–8220 lb./in.^{2} The apparent liquid densities of methane and ethane are shown to vary with the density of the system in which they are present. A method is proposed whereby the densities of liquid hydrocarbon mixtures containing both methane and ethane in solution may be computed at elevated temperatures and pressures within the accuracy of usual engineering computations. A method is outlined by means of which the shrinkage of crude oils may be calculated from the gas–oil ratio, gas analysis, and crude gravity. G. D. H.

177. Analyses of Crude Oils from Some Fields of Oklahoma. II. Southern Oklahoma. E. L. Garton. *U.S. Bur. Mines. Report of Investigations*, No. 3592, October 1941.—This report is a continuation of the study of Oklahoma crude oils being made by the Bureau of Mines Petroleum Experiment Station, Bartlesville, Oklahoma, and refers to that part of the State lying south-west of the Arbuckle Mountains, and embracing the counties of Carter, Cotton, Garvin, Jefferson, Kiowa, and Stephens.

Analyses are given of twenty-seven samples obtained from twenty-one different fields in the area, and the physical and chemical characteristics of these crude oils are briefly discussed.

In addition to the usual analytical data, correlation index figures are included. These, taken in conjunction with all other available data, form the basis of conclusions reached as to possible uses of these oils. At first sight it seemed that the prospect of obtaining good-quality gasoline was uneconomic, owing to the relatively high sulphur content of the oils. However, improved methods of desulphurization may prove technically and economically practicable. Moreover, if the sulphur were removed, it is believed that certain of these gasolines would be found to have exceptionally good anti-knock values. H. B. M.

Gas

178. Natural Gasoline and Liquefied Petroleum Gases. G. R. Hopkins and A. T. Coumbe. *U.S. Bur. Mines. Minerals Yearbook, Review of 1940, with Final Statistics for 1939.*—In spite of the fact that a new record production of 2,320,458,000 gal. of natural gasoline was established in the United States in 1940, the industry as a whole did not experience a particularly profitable year compared either with 1929, when the previous record was reached, or with 1939. This was due to the fact that the average value of gasoline at the plants fell from 7·1 cents a gallon in 1929 to 4·2 cents in 1939, and then to approximately 3·0 cents in 1940—an abnormally low price for refinery gasoline.

As a result probably of reduction of yield of gasoline in favour of fuel oils, there was a loss in refinery deliveries of natural gasoline during the year 1940, although the proportion used in refinery gasoline showed little alteration. This position, together with the gain in production, resulted in a considerable gain in stocks, as compared with a nett withdrawal in 1939.

The industry was further depressed by a continued fall in exports as a result of the war. Only 71,694,000 gal. were exported in 1940, compared with 172,662,000 gal. in 1939. Most severe cuts in shipments were those to the Netherlands West Indies—from 63,177,000 to 4,362,000 gal.; United Kingdom—from 33,629,000 to 8,361,000 gal.; and Japan—from 7,611,000 to 213,000 gal. The decline was attributable chiefly to the United States ban on exports of materials suitable for aviation fuel. H. B. M.

179. Natural Gas. F. S. Lott and G. R. Hopkins. *U.S. Bur. Mines. Minerals Yearbook, Review of 1940, with Final Statistics for 1939.*—Defence programme demands during 1940 were reflected in an 8% increase in marketed production of natural gas in the United States. Estimated consumption (marketed production less exports) was 2,667,010 million cu. ft., as opposed to 2,473,765 million cu. ft. in 1939. With the exception of petroleum refineries and electric power-plants, all major classes of consumers used more gas in 1940 than ever before. Domestic consumption also increased, largely owing to unusually cold weather in the early part of the year.

Exports to Mexico increased by 61% and totalled 4900 million cu. ft., while natural gas piped to Ontario, Canada (mixed with manufactured gas), amounted to 90 million as compared with 76 million cu. ft. in 1939. No natural gas was imported into the United States during 1940.

2382 gas-wells were completed during the year, representing an 11% increase, and reversing a declining trend which had been evident since 1937. Moreover, greater drilling activity was reported in eleven States, and moderate declines only in five.

The year 1940 was also noteworthy for the construction of the first large-scale equipment for storage of natural gas in liquid form. This involves a process of liquefying the gas by refrigeration to − 250° F. and construction of auxiliary equipment to store and regasify the liquid as required. As 1 cu. ft. of liquefied gas is equivalent to approximately 600 cu. ft. in gaseous form, construction of such equipment in fact provides storage for a volume of gas which could not be conserved above ground by any other known method.

Investigations concerning transportation and storage of natural gas in liquefied form reveal certain marked tendencies: dehydration processes are being more widely employed to prevent trouble from gas hydration and moisture in high-pressure lines; more gas companies are utilizing butane and propane to supplement gas supplies; and the importance of natural gas in defence and other industries is growing, both as a source of controlled heat and as a raw material for such commodities as plastics, textile fibres, and explosives. H. B. M.

See also Abstract Nos. 176 and 199.

Cracking

180.* Houdry Process Occupies Important Place in National Defence. Anon. *World Petrol.*, 1941 Ann. Refinery Issue, **12** (11), 52.—An outline is given of the development of the Houdry Process and modern improvements, and of its present status and possi-

bilities for providing fuel for national defence. Sixteen Houdry units are now in operation, having a combined catalytic cracking capacity of over 200,000 brl., and producing aviation and motor gasolines of 78–81 A.S.T.M. and 87–90 research octane numbers. The problem of revivification of the catalyst has been solved by incorporating perforated tubes in the catalyst bed which conduct air and oil into the bed and reaction products and regeneration gases from all parts of the bed, so that all the catalyst was being used or regenerated at the same time. The addition of fins to the tubes tended to reduce the maximum catalyst temperature during regeneration, further improvement being effected by the use of a separate cooling medium (molten salts) to remove the heat of regeneration. In modern plants the onstream time has been reduced to 10 min., so that the catalyst is used at its peak of activity before being seriously poisoned. The heat of catalyst regeneration is utilized in preheating the oil-feed and in manufacturing high-pressure steam. Compressed air is also used for the regeneration process. Owing to variations in the properties of the clay catalyst, synthetic catalysts have now been evolved, giving higher octane gasolines and rendering possible the direct production of low acid heat aviation gasoline of high quality. A 50% reduction in catalyst deposit is also obtained with certain charge-stocks. It is now possible to recycle the gas-oil through the unit, giving yields of up to 70% of motor gasoline of similar quality to that given by once-through operation.

Details are given of representative yields from Houdry recycle cracking, attention being directed to the high research and road octane values (see *J. Inst. Petrol.*, January 1942, Abs. No. 71). Houdry gasoline from cracking reduced crude has a high *iso*-paraffin content at the lower end, and a high aromatic and naphthene content at the higher end, the average composition being 36% paraffins, 22% naphthenes, 25% olefins, and 17% aromatics. The gasoline from catalytic cracking of gas-oil contains little olefins (average composition 46% paraffins, 26% naphthenes, 6% olefines, and 22% aromatics), and is of low acid heat and of octane rating equal to or better than the best straight-run gasolines. Data from catalytic cracking of various stocks indicates that the source has little effect on the quality of the aviation gasoline produced. By changing operating conditions gas-make can be increased, producing sufficient *iso*-butane for alkylation to bring the Houdry gasoline to 100 octane with 3 c.c. of T.E.L.

In the past 5 years more than a million brl. of Houdry aviation gasoline have been marketed. It is now considered that the presence of a certain amount of aromatics is necessary for best aviation performance under all flying conditions. With sufficient alkylate production, from 33 to 50% more 100 octane gasoline can be produced without requiring the blending of *iso*pentane. C. L. G.

181. Patents on Cracking. C. H. Greenewalt. U.S.P. 2,263,557, 25.11.41. Appl. 30.12.37. Production of ethylene and aromatic hydrocarbons by cracking a normally liquid hydrocarbon oil vapour derived from petroleum oil. The vapours are passed through a cracking zone heated to a temperature between 650° and 750° C., the passage being at such a rate that 40–60% of the vapours undergo the cracking reaction. Immediately afterwards the temperature is reduced to below 270° C. by quenching with a cold spray of hydrocarbon distillate. Resulting cracked products are separated into a fraction containing hydrogen and methane, a second fraction containing product olefins, a third fraction containing an aromatic distillate, and a fourth fraction comprising essentially ethane and C_3 and C_4 hydrocarbons freed of the desired product. The fourth fraction is cracked by passing it through a second cracking zone operated at a temperature at least 50° higher than that of the first cracking zone, but not exceeding 800° C. A similar cracking operation to that conducted previously is carried out, and cracked quenched products of the second operation combined with those obtained from the first.

G. C. Conolly. U.S.P. 2,264,434, 2.12.41. Appl. 6.12.38. Method of cracking hydrocarbon oils by contacting with an adsorbent siliceous catalyst containing alumina and a fraction of a per cent. of vanadium oxide in a cracking zone. The amount of vanadium oxide is just sufficient to improve the cracking activity of the catalyst.
H. B. M.

Polymerization and Alkylation

182.* New Thermal Polymerization Unit Installed By Pure Oil. C. M. Ridgway and P. A. Maschwitz. *Oil Gas J.*, 30.10.41, **40** (25), 30.—At the Pure Oil Co.'s Smiths Bluff Refinery a variety of crudes are processed in a variety of units to produce a wide range of products, and consequently refinery gas fluctuates in quantity and composition. The method to be used to convert the gas into marketable products had therefore to be flexible, and, after investigation, thermal polymerization was adopted. It was considered that increments in gasoline yield obtainable by increasing the recycle ratio above 5 : 1 or the reaction pressure above 1500 lb. per sq. in would not be economically sound. Further, since under definite conditions of pressure and recycle ratio the yield and character of the gasoline, especially its octane blending value, depend on the completeness of propane and butane extraction, a recovery process has been adopted, and the absorption method was selected as more suitable than refrigeration. The system gives a high propane recovery under conditions of low fresh feed, and about 50% recovery under full-load conditions. The raw gas is also desulphurized, since the polymerization process is efficient in converting H_2S into sulphur compounds boiling in the gasoline range, which decreases the octane number and the lead response of the gasoline. In addition, desulphurization minimizes corrosion and permits the use of cheaper and, in some cases, more desirable construction materials.

The actual process is in three main steps :—

1. Desulphurization,
2. Feed recovery and conversion,
3. Product treating and recovery,

and the description is illustrated with flow diagrams. H_2S is removed by scrubbing with aqueous diethanolamine solution in Girbotol units. After propane and butane absorption, the gas goes to the polymerization heaters, and then to the flash-towers. The desired vapour pressure is obtained by means of a stabilization tower, the overhead from which goes to a Gray vapour-phase unit, where it is clay-treated for gum removal.

Whilst the mechanical equipment is normal, the solutions of some of the problems are considered of interest and are given in some detail; in particular, the types of pumps, heat-exchangers, and condensers in use are described. Utility consumptions—*e.g.*, steam, water, power, etc.—are outlined in tables. Other tables give operating conditions, compositions of gas streams, and types of yields.

The process has increased average summer production of gasoline by 1000 brl. daily, and has substantially reduced the ethyl fluid consumption required for the entire refinery output of gasoline. J. C.

183. Patents on Polymerization and Alkylation. Universal Oil Products Co. E.P. 541,585, 2.12.41. Appl. 19.5.39. Process for the continuous conversion of butylenes contained in normally gaseous hydrocarbon mixtures into polymer olefins boiling within the gasoline boiling range. A current of a liquified hydrocarbon fraction consisting essentially of butanes and *iso*- and normal butenes is preheated, and thereafter contacted with a solid catalyst consisting of a precalcined mixture of phosphoric acid and a siliceous carrier.

E. W. Thiele. U.S.P. 2,263,056, 18.11.41. Appl. 28.1.38. Improved process of converting heavy hydrocarbon oils into gasoline. Gaseous hydrocarbons, including hydrogen and methane, are treated with a polymerization catalyst at a temperature between 250° and 600° F. In this way unsaturated gases are polymerized into gasoline and some polymers heavier than gasoline. Next the polymer gasoline is separated from the heavier polymers and unpolymerized gases, and the unpolymerized gases subjected to a pressure between 500 and 2000 lb. per sq. in. Thereafter the compressed gases are fractionated, and hydrogen and methane removed. The remaining hydrocarbons are heated to a temperature between 900° and 1300° F. without substantial reduction of pressure in a gas pyrolysis zone. In this way the gases are substantially converted into gaseous olefins and liquid hydrocarbons boiling within the gasoline range. The latter are separated, and the gaseous olefins recycled back to the catalytic gas polymerization stage of the process.

H. H. Meier. U.S.P. 2,264,447, 2.12.41. Appl. 13.4.39. Method of recovering *iso*pentane from a hydrocarbon mixture containing it in combination with normal pentane and amylenes. The mixture is reacted with an added *iso*paraffin other than *iso*pentane in the presence of an alkylation catalyst, and a fraction consisting essentially of *iso*pentane recovered from the alkylation product. H. B. M.

Refining and Refinery Plant

184.* Caustic-Methanol Mercaptan Extraction Process Used. H. W. Field. *Oil Gas J.*, 25.9.41, **40** (20), 40.—It is claimed for this process, developed by the Atlantic Refining Co., that the tetraethyl lead saving caused by elimination of octane rating loss and the increase in lead susceptibility will not only pay for the operating costs, but, in addition, yield a profit. Older methods of sweetening were always a debit to the refiner, since even under the best conditions they improved only the odour of the gasoline. The use of caustic washing units with regeneration was an advance on sweetening alone, substantially improved the lead susceptibility, but only partly removed the mercaptans, necessitating subsequent sweetening. The present process is said to give in a single operation a finished gasoline of sweet odour and negligible mercaptan content. Operating costs are low, since the reagents are cheap, are used only in small quantities, and are almost completely recovered. There is a saving in gasoline, since refining losses are very slight, in ethyl fluid, and hence in lead, chlorine, and bromine, and also in refining chemicals, including those normally used in sweetening. A much higher proportion of sour crudes becomes available, whilst much new plant construction for the purpose of operating new processes to meet mounting octane requirements may be avoided. Other advantages are that the process can handle gasoline of high phenol content, without using special preliminary caustic scrubbers, and that the treated gasoline has an excellent inhibitor response.

The process description is amplified by a simplified flow-diagram and by photographs. The sour gasoline passes into the base of a conventionally operated counter-current extraction column, packed with Raschig rings. Methanol is introduced into the middle of the column and aqueous caustic soda near the top. The treated gasoline disengages at the top of the tower, and the caustic-methanol solution, from the bottom, passes to a stripping column fitted with an internal boiler. From the base of this the regenerated caustic passes back to the extraction column, whilst methanol-water from overhead passes to a separator, where mercaptan is removed. The alcohol is concentrated by fractionation and returned to the extraction column. J. C.

185.* Distillate Production for Direct Utilisation. Anon. *World Petrol.*, 1941, Ann. Refinery Issue, **12** (11), 57.—The economic value of recycling plants for the production of water-white light distillates from gas-wells is discussed, and typical analyses of such distillates are given. Thirty-four recycling plants handling 2,000,000,000 cu. ft. of gas daily are in operation and ten more are planned or under construction. Previous methods of recovery of condensate from gas-wells were restricted to areas where there was a market for the gas or where it could be wasted into the air in relatively small quantities. The present method, which was developed in 1937, consists of delivering the gas at well-head pressure to the plant, separating the condensate at high pressure, compressing the residue gas, and returning it to the well. Apart from surface recovery of condensate, the process reduces the loss of distillate by condensation in the reservoir below the dew-point of those hydrocarbons of which the distillate is composed. On some plants pressure is maintained by cooling exchange with water, gas exchange with cold dry gas, and ammonia refrigeration, at 1200 lb. Circulation of brine in the wet gas-stream prevents hydrate formation and permits temperatures as low as 10° F. The gas thus saved provides a useful reservoir for future requirements. Present condensate production is about 35,000 brl. per day on Gulf Coast plants and 15,000 brl. per day in Kern County, California. Typical condensates after stabilization are doctor and corrosion negative, of good colour, odour, and low sulphur content. End-points vary from 385° F. to 606° F., the products distilling 28–74% to 212° F. The residue on distillation is normally kerosine. No chemical treatment of the gasoline is required, and the lead response is high, 1–1·36 c.c. of T.E.L. being required to raise the O.N. from 54·1–58·0 to 72. A further

advantage is the saving in transportation costs, the gasoline being thus available at the field. C. L. G.

186.* Refiners to Concentrate on 100 Octane. J. C. Morrell and G. Egloff. *World Petrol.*, 1941, Ann. Refinery Issue, **12** (11), 70.—A summary is given with flow-sheets and operating details of the following processes available for the production of 100 octane gasoline or high-octane-rating blending components :—

1. Cold acid polymerization at 65–80° F. of *iso*butylene to *iso*-octane ;
2. Hot acid polymerization at 175° F. of mixed butenes to octanes ;
3. Ipatieff solid phosphoric acid catalytic polymerization (selective or non-selective) of olefines, followed by hydrogenation and a combination dehydrogenation polymerization hydrogenation process in which aviation gasoline is produced from *iso*- and normal butanes, by low-pressure catalytic hydrogenation of the polymer ;
4. Alkylation in the presence of sulphuric acid in which an olefin—*e.g.*, butene—is directly added to *iso*butane to form an *iso*paraffin. The volume of *iso*butane available can be increased by isomerization of normal butane, using an aluminium chloride catalyst ;
5. Hydroforming in which aromatic hydrocarbons are produced in the presence of a catalyst by the hydrogen supplied by recirculating product gas ;
6. Catalytic cracking—*e.g.*, of the Houdry type using an activated hydrosilicate of aluminium.

Average commercial 100 octane gasoline (army method) consists of 40% of 95 O.N. *iso*-octane, 45% of 74 O.N. aviation straight-run, and 15% of 90 O.N. *iso*pentane, whilst 100 octane (motor method) can be blended from 45% *iso*-octane, 40% straight-run, and 15% *iso*pentane. The practical advantages of 100 O.N. over 87 O.N. gasoline in airplane performance is shown by comparative data on maximum speed, rate of climb, maximum output, etc. C. L. G.

187. Patents on Refining and Refinery Plant. J. S. Rowntree. E.P. 541,022, 10.11.41. Appl. 8.5.40. Improvement in apparatus for purifying used oils by treating them with clay and redistilling them at elevated temperatures and under reduced pressure to remove solid particles from the oil, and also diluents such as petrol, etc.

N.V. de Bataafsche Petroleum Maatschappij. E.P. 541,402, 26.11.41. Appl. 22.2.40. Process for refining a hydrocarbon oil which is free from asphalt but contains harmful sulphur in the form of mercaptan and disulphide sulphur. The oil is heated at a temperature between 205° and 370° C. with at least 1 mol. of cuprous oxide, containing less than 10% of cupric oxide, per mol. of mercaptan sulphur in excess of 10%. The process is continued for a sufficient length of time to convert disulphide sulphur and mercaptan sulphur into cuprous sulphide.

L. Dillon and C. E. Swift. U.S.P. 2,261,108, 4.11.41. Appl. 27.4.36. Process for deasphaltizing oil. The oil is mixed with a diluent to precipitate asphalt, tar, resin, colour bodies, etc., and then subjected to an electric field. Afterwards the precipitated materials are separated from the oil.

F. M. Archibald. U.S.P. 2,261,206, 4.11.41. Appl. 30.12.39. Preparation of mineral-white oils by exhaustively treating petroleum oils of lubricating-oil range with sulphuric acid. The resulting heavy sludge is separated from the oil-layer, which contains finely suspended sludge. Next the oil-layer is blown with air and the sludge material thus formed separated from the oil-layer. The clarified oil is neutralized with an alcoholic alkali solution, the alcoholic layer removed and the oil dried.

C. L. Read. U.S.P. 2,261,287, 4.11.41. Appl. 19.11.38. Improved method of treating relatively heavy petroleum oils having a high carbon content. The oil is countercurrently contacted with a phenol solvent under conditions designed to produce a raffinate phase and a solvent extract phase. The raffinate phase is then removed from the solvent extract phase and the solvent separated therefrom. The

solvent extract phase is cooled to a temperature between 50° and 100° below the temperature in the countercurrent treating tower at the point of withdrawal of the solvent extract phase. About 5–10% of water is added to the cooled solvent extract, and thus 40–60% of the extract oil is precipitated as a cycle oil. The cycle oil is segregated from the extract oil and the solvent removed from the respective phases. The solvent-free cycle oil is then distilled to remove from 40% to 60% of the same as a high-quality, substantially carbon-free product. 40–60% of the cycle oil is removed as a bottoms from the distillation operation and combined with the solvent-free extract oil.

C. F. Holm. U.S.P. 2,261,724, 4.11.41. Appl. 21.4.39. Method of dewaxing hydrocarbon oil to which has been added a diluent which is a preferential solvent for the oil and which has been chilled to precipitate the wax. The mixture is subjected to a multi-stage centrifugal operation, as a result of which substantially all the wax is separated from the oil without recirculating any of the wax and without necessarily recirculating any of the oil.

M. S. Agruss and G. W. Ayers. U.S.P. 2,261,866, 4.11.41. Appl. 2.10.39. Method of treating sulphur-bearing hydrocarbon oil containing paraffinic and non-paraffinic constituents. The oil is contacted with a reagent selected from the group consisting of morpholine and its derivatives. Thereafter the mixture is subjected to conditions which produce liquid phases. These phases are then separated to produce fractions of the oil which are relatively more, or relatively less, paraffinic and have a reduced sulphur content. Finally the reagent is separated from the fractions.

J. W. Orelup. U.S.P. 2,262,466, 11.11.41. Appl. 31.5.38. Stabilization of a petroleum distillate tending to be unstable in the presence of light by the addition of a compound selected from the group consisting of binaphthalene oxide, *iso*binaphthalene oxide, and binaphthalene dioxide.

W. A. Proell. U.S.P. 2,263,102, 18.11.41. Appl. 15.12.39. Method of decolorizing a petroleum oil which involves wetting a decolorizing clay with 40–110% by weight of sulphuric acid of 60–95% strength and percolating the mineral oil through a bed of the acid-wetted clay.

W. A. Schulze. U.S.P. 2,264,220, 25.11.41. Appl. 9.11.38. Method of sweetening mercaptan-containing light petroleum oil by dissolving air in the oil. Thereafter the oil is contacted with a solid sweetening reagent consisting of an absorbent material impregnated with a solution of a copper salt and a chloride. The sweetened oil is then passed to a zone of lower pressure to remove a substantial amount of the oxygen-denuded air, and a controlled portion of the sweetened gasoline recycled to the mercaptan-containing oil prior to the point of air introduction.

N. E. Lemmon and D. W. Bransky. U.S.P. 2,264,004, 2.12.41. Appl. 17.4.39. Improved process of preparing white mineral oil in which a mineral oil distillate is treated with a number of portions of fuming sulphuric acid and the sludge formed is removed prior to the addition of each subsequent portion of acid. The improvement lies in removal of substantially all of the black sludge acids from the acid-treated oil.

H. B. M.

Chemistry and Physics of Petroleum

188. Separation of Hydrocarbons by Azeotropic Distillation. B. J. Mair, A. R. Glasgow, Jr., and F. D. Rossini. *Bur. Stand. J. Res., Wash.*, 1941, **27** (1), 39–63.—In the work on the chemical constitution of petroleum, the separation of pure hydrocarbon compounds is accomplished by the appropriate interlocking of the fractionating processes of distillation, crystallization, extraction, and adsorption. However, it may frequently happen that distillation alone in its several variations may suffice to bring about a substantially complete separation of given hydrocarbons or of groups of isomeric hydrocarbons.

The principles involved in azeotropic distillation are discussed and the three systems illustrated: (*a*) no azeotropic mixture formed, (*b*) formation of a maximum boiling mixture, (*c*) formation of a minimum boiling mixture.

With some exceptions nearly all polar organic molecules of suitable volatility form with hydrocarbons minimum boiling azeotropic mixtures. Such organic molecules include those containing OH, COOH, CN, NH_2, and NO_2 groups.

In terms of the difference in b.pt. between the lower-boiling pure component and the minimum-boiling azeotropic mixture the lowering is greatest for the paraffins, and diminishes in the order naphthenes, mono-olefines, diolefines, and aromatics. Data are given for the azeotropic mixtures of members of these various types of hydrocarbon with ethyl alcohol, and it is shown that when the b.pt. of the hydrocarbon is considerably below that of the polar substance the composition of the azeotropic mixture will be high in the given hydrocarbon. As the b.pt. of the hydrocarbon increases the composition of the azeotropic mixture becomes leaner in hydrocarbon. Data are also given for azeotropic mixtures of benzene with primary, secondary, and tertiary alcohols.

In a general discussion on separation by azeotropic distillation it is recommended that the azeotrope-forming substance should:—

1. Have a b.pt. not more than 30–40° C. away from the boiling range of hydrocarbons to be separated;
2. Be completely soluble in water;
3. Be completely soluble in the hydrocarbon at the distillation temperature;
4. Be readily obtainable in pure state;
5. Be non-reactive with the hydrocarbons or the still material.

It is also necessary that the mixture of hydrocarbons to be separated should have previously been fractionated into a series of substantially constant-boiling fractions. Results are presented of azeotropic distillations, each performed as a single batch distillation in a column with a separating efficiency of 90–100 theoretical plates. These include separation of:—

(*a*) Aromatics from naphthenes and paraffins;
(*b*) Naphthenes from paraffins;
(*c*) Various kinds of aromatics from one another;
(*d*) Various kinds of naphthenes from one another.

The benefit of distillation at reduced pressure prior to azeotropic distillation is also considered. In general, the different types of hydrocarbons show significantly different changes in b.pt. with pressure, and a primary separation by this means is suggested. A general scheme for separating hydrocarbons by distillation alone is presented.

Finally, a list is given of hydrocarbons which, it is known, can be separated by distillation alone in its several variations of normal and reduced pressures and distillation with an azeotrope-forming substance. D. L. S.

189. Heats of Isomerization of the Five Hexanes. E. J. R. Prosen and F. D. Rossini. *Bur. Stand. J. Res., Wash.*, 1941, **27** (3), 289.—Calorimetric measurements have been made which yield values for the differences in the heats of combustion of the five hexanes in the liquid state at 25° C.

These values, which are also the heats of isomerization in the liquid state at 25° C., have been combined with calculated values for the differences in the heats of vaporization to give values for the heats of isomerization in the gaseous state at 25° C. With a knowledge of the heat content of the various isomers in the gaseous state as a function of the temperature, it has been possible to obtain values for the heats of isomerization in the gaseous state at several temperatures from 0° to 1000° K.

In carrying out the determinations, the values of the ratio of the heat of combustion of each isomer of hexane to that of normal hexane have been determined as accurately as possible. The apparatus and method used are described fully, and the procedures for the purification of the five hexanes outlined.

The following values for the heats of isomerization were obtained for the liquid state at 25° C. and calculated to the gaseous state at 298° and 0° K. The figures for the gaseous state at 600° and 1000° K. were calculated, utilizing data calculated by Pitzer for each of the isomers at these temperatures.

	Heat of isomerization for $nC_6H_{14} = iC_6H_{14}$.				
	Liquid.	Gas.			
	25° C.	0° K.	298° K.	600° K.	1000° K.
	kg.-cal./mole.	kg.-cal./mole.	kg.-cal./mole.	kg.-cal./mole.	kg.-cal./mole.
n-Hexane	0	0	0	0	0
2-Methyl-pentane	−1·30±0·21	−1·04±0·25	−1·68±0·23	−1·40±0·25	−1·18±0·28
3-Methyl-pentane	−0·76±0·19	−0·42±0·23	−1·09±0·21	−0·78±0·23	−0·36±0·26
2 : 3-Dimethyl-butane	−1·96±0·20	−1·89±0·24	−2·58±0·22	−2·05±0·24	−1·63±0·27
2 : 2-Dimethyl-butane	−3·49±0·18	−3·60±0·23	−4·44±0·21	−4·16±0·23	−3·44±0·26

D. L. S.

190. Isolation of 1 : 2 : 3 : 4-Tetramethylbenzene, 5 : 6 : 7 : 8-Tetrahydronaphthalene, 1-Methyl-5 : 6 : 7 : 8-Tetrahydronaphthalene, and 2-Methyl-5 : 6 : 7 : 8-Tetrahydronaphthalene from Petroleum. B. J. Mair and A. J. Streiff. *Bur. Stand. J. Res., Wash.*, 1941, **27** (4), 343.—This paper constitutes the second report of the work on hydrocarbons in the kerosine fraction of the petroleum which is being investigated by the Bureau.

The aromatic fraction of the kerosine which distilled 114–144° C. at 56 mm. Hg was distilled at 56·8 mm. Hg, producing a series of constant-boiling fractions. Then by azeotropic distillation and fractional crystallization 1 : 2 : 3 : 4-tetramethylbenzene and 5 : 6 : 7 : 8-tetrahydronaphthalene were isolated from fractions distilling 118–120·5° C. at 56·8 mm. Hg, 2-methyl-5 : 6 : 7 : 8-tetrahydronaphthalene from fraction 137–140° C. at 56·8 mm. Hg, and 1-methyl-5 : 6 : 7 : 8-tetrahydronaphthalene from fractions distilling 141–144° C. at 56·8 mm. Hg.

Further azeotropic distillation and recrystallization were utilized to separate and purify these hydrocarbons.

The purification of the 1 : 2 : 3 : 4-tetramethylbenzene was followed by determinations of the refractive index and freezing point. As, however, little reliable data had been published for the other three hydrocarbons, synthetic samples of these were obtained and purified.

The amounts of impurity in the "best" lots of each of the four hydrocarbons from petroleum and in the three synthetic samples were estimated as follows, in mole fraction :—

Hydrocarbon.	From petroleum.	Synthetic materials.
1 : 2 : 3 : 4-Tetramethylbenzene	0·0006±0·0001	—
5 : 6 : 7 : 8-Tetrahydronaphthalene	0·015 ±0·002	0·0057±0·0008
1-Methyl-5 : 6 : 7 : 8-tetrahydronaphthalene	0·0029±0·0004	0·0034±0·0005
2-Methyl-5 : 6 : 7 : 8-tetrahydronaphthalene	0·0046±0·0007	0·031 ±0·004

Values of certain physical properties all extrapolated to zero impurity were determined as follows :—

	1 : 2 : 3 : 4-Tetramethylbenzene.	5 : 6 : 7 : 8-Tetrahydronaphthalene.	1-Methyl-5 : 6 : 7 : 8-tetrahydronaphthalene.	2-Methyl-5 : 6 : 7 : 8-tetrahydronaphthalene.
B.pt. at 760 mm. ° C.	205·04±0·03	207·57±0·10	234·35±0·05	229·03±0·05
Freezing pt. in air at 1 atmos. ° C.	−6·25±0·01	−35·80±0·02	−22·90±0·03	−39·75±0·03
Density at 25° C. g./ml.	0·9015±0·0001	0·9662±0·0002	0·9682±0·0002	0·9500±0·0002
Refractive Index at 25° C.:				
nC	1·51362±0·00007	1·53466±0·00015	1·53738±0·00010	1·52920±0·00010
nD	1·51811±0·00007	1·53919±0·00015	1·54190±0·00010	1·53365±0·00010
nF	1·52923±0·00007	1·55065±0·00015	1·55325±0·00010	1·54498±0·00010
Specific dispersion at 25° C. $\frac{(nF - nC)}{d}$	0·01732±0·00005	0·01655±0·00010	0·01639±0·00005	0·01662±0·00005

D. L. S.

191. Patents on Chemistry and Physics of Petroleum. M. de Groote and B. H. Keiser. U.S.P. 2,262,357, 11.11.41. Appl. 27.6.40. Process for resolving petroleum emulsions of the water-in-oil type by subjecting them to the action of a demulsifier consisting of a product of the kind derivable by an acylation reaction between: first, a high-molecular-weight monocarboxy-acid; and, second, a cyclic polyamine having at least one of the following radicles: arylamine, hydroaromatic amine, dipiperidyl, piperidylpyridine, piperazine, piperidine, pyridine, cyclic imido ether, cyclic amidine, and cyclic triethylene triamine radicles. The acylated derivative is characterized by the presence of at least one basic amino-nitrogen atom and by freedom from quaternary ammonium radicles.

M. de Groote and B. H. Keiser. U.S.P. 2,262,358, 11.11.41. Appl. 27.6.40. Process for breaking petroleum emulsions of the water-in-oil type by subjecting them to the action of a demulsifier consisting of an acylation derivative of a polyamine. The acylation product is characterized by the presence of (*a*) at least one high-molecular-weight carboxy-acid radicle, and (*b*) at least one polybasic carboxy-acid radicle. Additionally it is characterized by the fact that there is at least one polybasic carboxy-acid radicle acting as a linking radicle between the amine residue and a high-molecular-weight carboxy-acid residue.

M. de Groote and B. H. Keiser. U.S.P. 2,262,736, 11.11.41. Appl. 27.6.40. Process for breaking petroleum emulsions of the water-in-oil type which involves subjecting them to the action of a demulsifier consisting of a polyglycol ether produced by reacting an alkylene oxide with an acylation product derived by reaction between a ricinollic acid body and an acylation-reactive amine.

M. de Groote. U.S.P. 2,262,743, 11.11.41. Appl. 12.5.41. Process for breaking petroleum emulsions of the water-in-oil type by subjecting them to the action of a demulsifier consisting of oxyalkylated imidazolines substituted in 2-position by a radicle containing 11–22 carbon atoms and selected from the group consisting of alicyclic hydrocarbon radicles, aliphatic hydrocarbon radicles, and aliphatic hydrocarbon radicles substituted by hydroxyl radicles. H. B. M.

Analysis and Testing

192. Correlation of the Chemical and Electrical Changes Observed during the Oxidation of Mineral Insulating Oil. F. M. Clark. *Proc. 43rd A.M., A.S.T.M.*, **1940**, **40**, 1213–1234.—Of the many chemical and electrical tests which have been suggested as a means of examining the deterioration of an oil, no one test has been found sufficient for evaluating the important properties of a good mineral transformer oil—namely, retension of high dielectric strength and resistance to sludge formation, the latter property having proved particularly difficult to evaluate.

An analysis is made of the value in estimating oil deterioration of tests for the following properties: hydrophil, restivity, colour, acidity, potential sludge formation, power factor, and dielectric strength. The limitations of the colour and acidity tests in the determination of oil quality are shown by graphs in which the colour and acidity are plotted against the potential sludge formation value, and these show that, at a certain point, neither the colour nor the acidity changes appreciably, despite a continued increase in the potential sludge formation value. The latter, as determined by a long-time high-pressure oxidation procedure, is itself of value, and bears a linear relation to the power factor, which, however, is affected by the presence of contaminating materials and by uncontrolled factors in commercial transformer operations. The dielectric strength appears to be unaffected by dielectric changes in the oil, as shown by changes in the power factor, and to be unrelated to the colour, acidity, or potential sludge formation value.

The changes in power factor, acidity, and ester value of highly refined mineral oil produced by oxidation in open and sealed glass containers are discussed. J. F. T

Motor Fuels

193.* Research to Meet Motorists' Demand for 100 Octane Fuel. Anon. *World Petrol.*, 1941, Ann. Refinery Issue, **12** (11), 66.—The Bureau of Mines 1941 winter report (RI. 3576) on the trend of gasoline quality is summarized and discussed, and the methods used by refiners to meet the increasing demand for higher octane number are outlined. Increases in the octane ratings of the different winter grades from the

period 1935–36 to the period 1940–41 were as follows: Regular grade 69·6–74·4, premium grade 76·7–80·2, and third grade 57·5–65·6. In general, gasolines contain more high-boiling components, and vapour pressure of premium and third grade has increased. Summer grades tend to be rather higher in octane rating than the winter grades. The great increase in octane rating can no longer be satisfied by leading, and refiners have been compelled to instal equipment for catalytic cracking, polymerizing, isomerization, alkylation, hydro-forming, poly-forming, etc. It appears possible that in a few years the higher-priced automobiles will be designed for 90 or even 100 O.N. gasolines. To obtain 90 O.N. gasolines will require processes such as Houdry catalytic cracking or hydro-forming followed by leading, but above this figure new cracking processes will be required unless *iso*-octane, neohexane, or the new triptane can be cheaply produced. Current production of 100 O.N. gasoline in the U.S. is estimated at 40,000 brl. per day, rising to 54,000 brl., and military requirements as 20,000,000 brl. per annum. Fifty new plants are contemplated, the only serious factor in reaching the required production being the time required to instal the equipment. C. L. G.

194. Patents on Motor Fuel. N.V. de Bataafsche Petroleum Maatschappij. E.P. 540,824, 31.10.41. Appl. 8.12.39. Production of higher-boiling hydrocarbons from olefines by continuously feeding a monomeric olefine having at least six carbon atoms in the molecule to a dispersed circulating mixture of an *iso*paraffin or hydrocarbon mixture containing an *iso*paraffin and 85–110% of sulphuric acid. Dispersion is maintained at a temperature between 50° and − 20° C. and feeding of the olefine is so regulated that the molar ratio of *iso*paraffin to olefine at the instant of olefine introduction is at least 2 to 1.

Standard Oil Development Co. E.P. 541,067, 12.11.41. Appl. 6.2.40. Improved process for catalytically reforming naphthas by conducting the operation in the presence of 0·1–2% by weight of sulphur calculated on the weight of naphtha treated. The naphthas to which the process may be applied are hydrocarbon oils boiling substantially in the motor-fuel range. These may be derived from any source—*e.g.*, products of distillation, hydrogenation, cracking of coals, tars, mineral oils, shales, peats, lignites, etc., or products of synthetic processes such as the Fischer synthesis.

Anglo-Iranian Oil Co. E.P. 541,106, 13.11.41. Appl. 8.3.40. Production of *iso*paraffins such as *iso*butane or *iso*pentane, or mixtures containing such *iso*paraffins. The normal paraffin or a mixture of hydrocarbons containing the normal paraffins in admixture with a hydrogen halide is contacted with a solid catalyst consisting of alumina alone or alumina and an inert substance or substances.

G. H. Freyermuth and A. E. Robertson. U.S.P. 2,263,239, 18.11.41. Appl. 24.8.39. Preparation of a motor fuel consisting substantially of a cracked gasoline which has been almost wholly freed of unsaturated aliphatic hydrocarbons having more than one double bond per molecule, and which has been reduced to a sulphur content of less than 0·1%. The motor fuel contains, in addition, 5–20% of butadiene, 0·5–20 mg. of tricresol per 100 c.c. fuel, and 0·5–6 c.c. of lead tetraethyl per gallon of fuel.

W. E. Forney. U.S.P. 2,263,266, 18.11.41. Appl. 19.2.36. Method of manufacturing a high anti-knock motor fuel by passing a hydrocarbon mixture containing substantial proportions of unsaturated olefine hydrocarbons through a zone in intimate contact with phosphoric acid. A temperature of approximately 375° F. is maintained in the zone, and also a superatmospheric pressure. In this way portions of the hydrocarbons are converted into constituents condensable under conditions obtaining in the zone. Thereafter a liquid oily product is withdrawn from the zone and washed to remove any acidic constituents. The resultant washed oil is blended with a low-octane motor fuel to increase substantially its octane rating.

B. H. Shoemaker and J. R. Wilson. U.S.P. 2,264,894, 2.12.41. Appl. 27.9.39. Preparation of a motor fuel consisting of cracked hydrocarbon distillates of the character of gasoline which normally tend to deteriorate and develop gum, and a small amount of the condensation product formed by reacting a compound selected from the class consisting of aldehydes and ketones free of hydroxy-substituents with an organic primary diamine. The condensation product is added in sufficient quantity to retard deterioration of the cracked hydrocarbon distillates.

C. E. Adams. U.S.P. 2,265,051, 2.12.41. Appl. 27.9.39. Production of a motor fuel consisting of cracked hydrocarbon distillates of the character of gasoline which normally tend to deteriorate, and a small proportion of the condensation product obtained by reacting a compound selected from the group consisting of aldehydes and ketones free of hydroxy-substituents with an organic polyamine having at least three amino-nitrogen atoms, of which at least two are primary. H. B. M.

Gas, Diesel, and Fuel Oils

195. Patents on Gas, Diesel, and Fuel Oils. G. H. Cloud. U.S.P. 2,261,227, 4.11.41. Appl. 21.4.39. Preparation of a fuel for compression-ignition engines of the diesel type. The fuel consists of a hydrocarbon diesel fuel blended with a phosphite ester of a compound selected from the group consisting of hydroxyl alcohols and thio-alcohols. The ester contains three organic groups, each of which has an alkyl group. The hydrocarbon components of the fuel boil below 700° F., and the ester is added in sufficient amount substantially to enhance the ignition quality of the fuel.

R. Rosen. U.S.P. 2,261,290, 4.11.41. Appl. 22.12.38. Preparation of a fuel for compression-ignition engines of the diesel type. The fuel consists of a hydrocarbon diesel fuel blended with a thiophosphate ester containing in the molecule three to four sulphur atoms and three organic groups, each of which has an alkyl group. The hydrocarbon component of the fuel boils below 700° F., and the ester is added in sufficient amount substantially to enhance ignition properties of the fuel.

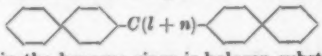
G. H. Cloud. U.S.P. 2,263,234, 18.11.41. Appl. 1.3.40. Manufacture of a high-speed diesel fuel consisting of hydrocarbon diesel fuel blended with a small proportion of alkyl trisulphide to improve ignition qualities of the fuel. H. B. M.

Lubricants and Lubrication

196. Recovery of Used Lubricating Oil. F. Frank. *Chem. Age*, 20.12.41, **45** (1173), 316.—In commenting on a recent paper by J. E. Walker appearing in *The Chemical Age*, the author gives reference to other works on the same subject. The great importance with which the subject is viewed in Germany is stressed, and certain great concerns the policy of which is to regenerate lubricating and transformer oils are named. It is urged that similar work would be beneficial to war-time as well as peace-time Britain. A. H. N.

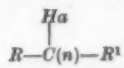
197. Patents on Lubricants and Lubrication. P. S. Allam. E.P. 541,384, 25.11.41. Appl. 29.5.40. The specification relates to oil filters of the kind comprising a mass of porous material through which oil, and more particularly oils used in the lubrication of internal-combustion engines, may be passed to remove suspended particles. It is also claimed that the filter neutralizes undesirable acidity of the oil. The filtering medium has mixed with it a salt or ester of an amino-acid having at least one amino-substituted hydroxyalkyl group.

W. A. Whittier. U.S.P. 2,261,862, 4.11.41. Appl. 18.12.37. Manufacture of a lubricant consisting of a mineral lubricating oil and a compound of the type



in which the hydrogen in the benzene rings is halogen substituted or unsubstituted, C is an aliphatic radicle having any number (n) of carbon atoms in excess of one, and a halogen is united to aliphatic carbon.

W. A. Whittier. U.S.P. 2,261,864, 4.11.41. Appl. 18.12.37. Preparation of an extreme-pressure lubricant consisting of a mineral lubricating oil and a halogenated compound of the type



R and R^1 are benzene nuclei in which one or more hydrogen atoms are substituted by alphyl radicles, C is a straight aliphatic chain having n carbon atoms, where n is three or more. Ha represents a halogen united to aliphatic carbon atoms linked between the benzene nuclei.

W. A. Whittier. U.S.P. 2,261,865, 4.11.41. Appl. 2.12.38. Preparation of a lubricant consisting of a mineral lubricating oil and a halogenated compound of the type

$$R—\underset{\displaystyle Ha}{\underset{|}{C}}(n)—R^1$$

R and R^1 are benzene nuclei, C is a straight aliphatic hydrocarbon chain having any number (n) in excess of four carbon atoms, and Ha represents a halogen united to one or more carbon atoms linked between the benzene nuclei.

B. H. Lincoln and G. D. Byrkit. U.S.P. 2,262,019, 11.11.41. Appl. 26.5.39. Preparation of a lubricant consisting of a major proportion of a mineral lubricating oil and a minor proportion of a compound containing two oxygen atoms in a heterocyclic ring.

B. H. Lincoln and A. Henriksen. U.S.P. 2,262,773, 18.11.41. Appl. 19.3.37. Preparation of a lubricant consisting of a major proportion of a lubricating oil and a minor proportion of a halogenated aromatic substituted fatty acid.

E. Lieber. U.S.P. 2,262,809, 18.11.41. Appl. 12.10.38. Preparation of a lubricant consisting of a waxy lubricating oil, a condensation product of halogenated "tall" oil, and a cyclic compound.

A. J. Morway and J. C. Zimmer. U.S.P. 2,262,813, 18.11.41. Appl. 13.8.38. Production of lubricant addition agents by heating an unsaturated terpenic compound with a phosphorus halide at a temperature between 250° and 375° F.

M. F. Finike and J. H. Bartlett. U.S.P. 2,263,265, 18.11.41. Appl. 24.2.38. Preparation of an improved lubricating oil of high spreading and penetrating ability. The composition consists of a mineral lubricating oil in which has been dissolved 1–5% of an ester of normal carbonic acid.

J. I. Wasson and W. M. Smith. U.S.P. 2,263,664, 25.11.41. Appl. 25.1.40. Preparation of a lubricating composition consisting of an oil and a small amount of a substance selected from the class of tertiary alkyl aromatic mono-ethers which are characterized by having at least two alkyl groups attached directly to the aromatic nucleus, one of which is a tertiary alkyl group, and the other an alkyl group containing at least two carbon atoms in the molecule.

B. H. Lincoln and G. D. Byrkit. U.S.P. 2,264,319, 2.12.41. Appl. 12.10.39. Preparation of a lubricant consisting of a major proportion of oil of lubricating viscosity and a small proportion of halogenated foots oil.

B. H. Shoemaker, J. W. Gaynor, and L. W. Mixon. U.S.P. 2,264,893, 2.12.41. Appl. 29.6.38. Method of inhibiting oxidation of a highly refined, viscous hydrocarbon oil by adding thereto, in combination, a high sulphur-containing fraction from a crude oil, and an organic compound selected from the class consisting of polyhydric phenols, alkyl polyhydric phenols, hydroxy-condensed poly-ring compounds and alkyl-hydroxy condensed poly-ring compounds.

W. H. Bahlke. U.S.P. 2,264,896, 2.12.41. Appl. 20.6.38. Manufacture of an oxidation resistant viscous hydrocarbon oil consisting of a highly refined viscous hydrocarbon oil normally susceptible to oxidation and small amounts of sulphurized sperm oil, and an organic compound having anti-oxidant properties selected from the class consisting of polyhydric phenols, alkyl polyhydric phenols, naphthols, and alkyl naphthols.

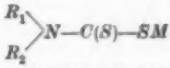
J. M. Musselman. U.S.P. 2,264,999, 2.12.41. Appl. 15.7.39. Preparation of a lubricant consisting of a mineral lubricating oil and a small amount of a salt of ring-containing amine compound selected from the group consisting of di*cyclo*hexylamine, diphenylamine, and hexamethylene tetramine; also a carboxylic acid from the group consisting of fatty acids of at least ten carbon atoms and naphthenic acid.

B. H. Lincoln and W. L. Steiner. U.S.P. 2,265,774, 9.12.41. Appl. 24.2.40. Preparation of a lubricant containing in combination a major proportion of a hydrocarbon oil, ½–10% by weight of a chlorinated carbon compound and from 0·001 to 2% by weight of a sterol.

J. C. Zimmer and A. J. Morway. U.S.P. 2,265,791, 9.12.41. Appl. 6.4.39. Preparation of an improved lubricating grease for use on ball and roller bearings at high temperatures, and consisting of a major proportion of mineral lubricating oil, sodium soap of a raw rapeseed oil, and an excess of free alkali over that necessary to saponify the rapeseed oil.

R. Rosen. U.S.P. 2,265,819, 9.12.41. Appl. 2.12.39. Preparation of a composition of matter consisting of a hydrocarbon oil boiling above the kerosine boiling range and a small amount of an oil-soluble organo-diphosphine compound. The latter is incorporated in sufficient amount to reduce the formation of varnish-like deposits on hot metal surfaces of internal-combustion engines lubricated by the composition.

G. L. Matheson. U.S.P. 2,265,851, 9.12.41. Appl. 8.5.40. Preparation of a lubricant consisting of a mineral lubricating oil and a dithiocarbamate compound of the formula



R_1 and R_2 are organic groupings of which $R_1 + R_2$ contains at least eight carbon atoms in alkyl groups, and M is a metal selected from the class consisting of alkaline earth metals and metals of the iron sub-group of the periodic system. H. B. M.

Asphalt and Bitumen

198. Asphalt and Related Bitumens. A. H. Redfield. *Minerals Yearbook Review of 1940*. U.S. Bur. Mines, 1941.—As in previous reports, this one takes care of production of native asphalt and bitumens, manufactured or petroleum asphalt, and road oil in the United States, also foreign trade in these commodities during the year 1940. It shows that the total domestic and foreign demand for petroleum asphalt (including Trinidad Lake asphalt and grahamite) was 9% in excess of that of 1939, and exports from the United States were also 30% greater. 458,665 tons of rock asphalt, 31,930 tons of gilsonite, and 70 tons of wurtzilite were produced in 1940. In that year petroleum refineries in the United States produced 8% more asphalt than in 1939. Some of these increases were due to foreign demands, though State highway construction was undoubtedly responsible for greater market activity, and roofing manufacture alone accounted for 24% of the total sales of asphalt during the year under review. In the matter of road oil, refinery returns indicate a slight increase on 1939, the amount being 8·5 million brl., of which only a comparatively small quantity, 56,000 brl., was shipped abroad. H. B. M.

Special Products

199. Helium. R. A. Cattell and C. W. Seibel. *Minerals Yearbook Review of 1940*. U.S. Bur. Mines, 1941.—The total output of helium in 1940 was approximately 156 million cu. ft., or more than 90% of the world's total production. The bulk of this output was obtained from helium-bearing natural gas produced from the U.S. Government's Cliffside gas-field and treated in the Bureau of Mines helium plant near Amarillo, Texas. As the Government owns gas rights over 50,000 acres at Cliffside (which covers the entire geological structure optimum for gas production), the field is operated according to approved engineering practice, and only when supplies of helium at Amarillo are actually required: this is conservation at its best. Hitherto practically all helium produced in the United States was appropriated by the War and Navy Departments, little, if any, being available for industrial and other domestic requirements. The chief plant up to 1929 was at Fort Worth, Texas, but this closed down owing to the natural gas supply feeding it being exhausted. With the advent of Amarillo, helium has become available for non-Government activities, and these include production of helium–oxygen mixtures to mitigate caisson disease, from which divers and caisson workers suffer; the use of helium as a diluent in anæsthetics to prevent fires and explosions; as a diluent for *cyclo*propane; as an aid to meteorologists in forecasting weather; as a general aid in scientific research. In the services helium is used for inflating lighter-than-air craft, for observational and meteorological balloons, and for barrage balloons as protection against air attack. The price of helium per 1000 cu. ft. in the year under review ranged from $8.4 for Government purposes to $13·1 for industrial, medical, and general scientific use. H. B. M.

200.* 62 Million Gallons of Toluene Yearly for National Defence. O. W. Willcox. *World. Petrol.*, 1941, Ann. Refinery Issue, **12** (11), 57.—The 1939 production of toluene in the United States from coal distillation amounted to about 20,000,000 gal., being

used for manufacture of solvents, dyestuffs, etc. It is calculated that in addition 50 to 60 million gal. of toluene per annum will be required for national defence. While toluene occurs in straight-run and cracked gasolines, the yield is generally very small in the former case and separation difficult in the latter, owing to the presence of azeotropic mixtures, although the use of selective solvents facilitates recovery. A plant has been constructed at a Houston refinery to produce 2 million gal. of toluene a year by fractional distillation, and this plant is being duplicated. A similar plant of 4 million gal. a year capacity is also being erected at an Illinois refinery. The recently perfected Kellogg hydro-forming process enables a yield of 80% of aromatics (of which 15 to 20% is toluene) to be obtained from heavy naphtha plus hydrogen-rich recycle gas. A hydro-forming unit capable of producing 5 million gal. of toluene a year is in operation at a Texas City refinery, and further plants at Ponca City and a Baytown refinery will produce 2,500,000 gal. and over 10,000,000 gal. toluene, possibly rising to 27,000,000 gal. Other hydro-forming units in operation but not scheduled for toluene could also be used. C. L. G.

201. Patents on Special Products. J. E. Edgar and H. A. Woods. U.S.P. 2,262,926, 18.11.41. Appl. 24.9.40. Preparation of a flushing-oil composition especially suitable for removing sludge and lacquerous deposits from internal-combustion engines. The composition consists of not more than 5% by weight of water, 2–10% by weight of diacetone alcohol, 5–25% by weight of a sodium salt of mahogany sulphonic acid having a p_H not exceeding 7, and the remainder a blend of mineral lubricating oil and a highly aromatic, liquid sulphur dioxide soluble petroleum extract boiling in the kerosine range. The composition has a viscosity of approximately 100 S.S.U. at 100° F. and a flash-point in excess of 150° F. as determined by the A.S.T.M. closed-cup method.

C. F. Reed. U.S.P. 2,263,312, 18.11.41. Appl. 30.6.38. Reaction of a highly paraffinic hydrocarbon fraction, essentially free from aromatic and unsaturated constituents, with a gaseous mixture of sulphur dioxide and chlorine. The invention also relates to the production of organic compounds containing sulphur, chlorine, and oxygen by bringing paraffinic hydrocarbons in the liquid state into contact with sulphur dioxide and chlorine while irradiating with short-waved light.

J. W. Orelup. U.S.P. 2,265,189, 9.12.41. Appl. 17.2.40. Preparation of a composition of matter consisting of a combination of diphenyl with a dyestuff and designed for use as a colouring agent for petroleum products.

E. W. Carlson. U.S.P. 2,265,799, 9.12.41. Appl. 16.4.40. Preparation of an oil emulsion consisting of a mineral oil, water, an emulsifying agent, and a foam suppressing salt selected from the class of salts produced by reacting an alkali metal hydroxide with an amphoteric oxide. H. B. M.

Detonation and Engines

202. Radioactive Spark Plug. Anon. *Chem. Tr. J.*, 21.11.41, **109** (2844), 256.—U.S.P. 2,254,169 granted to J. H. Dillon features a plating or alloy of a radioactive metal such as polonium on one or both electrodes, or the electrodes may be made from a nickel and polonium alloy. It is claimed that a spark will readily be generated by such a plug even when the battery is low. Tested at − 15°, 30% fewer revolutions were required to start the motor as compared with other plugs.

It is claimed that the longer the radioactive plug is used the more efficient it becomes. D. L. S.

203.* Correcting Engine-Test Data by Means of a Nomograph. R. O. Kinsey and E. E. Batzell. *Oil Gas J.*, 30.10.41, **40** (25), 40.—The A.P.I. standard rating test form for internal-combustion engines requires that horse-power values observed on test be corrected to conditions of 60° F. and sea-level altitude by use of the formula

$$H_s = H_o \times \frac{29{\cdot}92}{p} \times \sqrt{\frac{t + 460}{520}}$$

where H_s = brake horse-power under standard conditions, H_o = observed brake horse-power, p = observed barometric pressure in inches of mercury, and t = observed temperature in degrees F.

A nomograph is presented, by means of which this calculation may be avoided, together with a detailed explanation of the method used in its construction. J. C.

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Geology and Development

204.* Tansill Formation, West Texas and South-Eastern New Mexico. R. K. DeFord and G. D. Riggs. *Bull. Amer. Ass. Petrol. Geol.*, September 1941, **25** (9), 1713–1728.—The junction of the Tansill formation above with the Yates sand below is widely used in plotting structures of the Permian in the area where the Pecos river crosses the boundary between New Mexico and Texas. The Tansill consists of 6–18-in. magnesian limestones, marls, and silts, with average dip of 12°, S. 36° E., and is defined for 60 miles. Measurements of the type section on the Carlsbad dome, descriptions of the insoluble residues, and details of the contained Octillo silt member, grey in places, red in others, traceable for 100 miles, are provided. Along strike the Tansill thins on

anticlines to 95 ft. at the Getty pool and 115 ft. at Lake Avalon, but thickens to 165 ft. on the side of the Vickers synclinal. South-eastwards the Tansill increases to 300 ft., with gastropods, before grading into the Capitan limestone, in the top of which fusilinids, crinoids, and algæ are recognized. To the north-east, the layers of Tansill limestone, or at least the diastems between them, give place to beds of anhydrite.

If the Permian is taken as having lasted 40,000,000 years, it is suggested that the Tansill covers 500,000 years. On dividing this by 250 "horizons of interruption," it seems that each 6-in. stratum of limestone with associated interval of non-deposition represents 2000 years.

The top of the Tansill is equal in age to that of the Capitan, and corresponds with the Guadalupe–Ochoa break. To the south-east the Castile formation overlies the Capitan, and in part of the district north-east of Carlsbad laps against the Capitan reef-front. Elsewhere the Salado, and probably the Rustler, rest directly on the Tansill with disconformity. R. C. W.

205.* Geology of Southern Part of La Barge Region, Lincoln County, Wyoming. A. J. Bertagnolli, Jr. *Bull. Amer. Ass. Petrol. Geol.*, September 1941, **25** (9), 1729–1744.—The Palæozoic rocks of the north–south La Barge Ridge, west of the La Barge oil-field, are divided up for the first time. The Cambrian (more than 1160 ft.) begins with limestone, succeeded by thick shales with thin, glauconitic, worm and trilobite limestone bands, followed by brachiopod–trilobite limestone with edgewise conglomerate. After an angular unconformity of 3–6° comes the Ordovician Bighorn limestone (890 ft.), dolomitic but easily eroded, containing *Endoceras*. Next, after slight discordance, there is the Devonian Jefferson limestone (498 ft.), magnesian and sandy, with occasional *Atrypa reticularis*, and finally, above a likely unconformity, the Lower Carboniferous Madison formation (715 ft.), of platy and arenaceous limestones characterized by *Spirifer centronatus*. These Palæozoics are driven eastward by overthrusting along the Darby fault, and rest on Upper Cretaceous, which comprises the Hilliard Series (4200 ft.) of shales and sands with *Scaphites*, and the Adaville cross-bedded sands and lignites (1000 ft.). Unconformable over all the preceding is the Almy (600 ft.), of red and white conglomerates, sands, and clays, seemingly Eocene. Secondary thrusting from the west now took place on the site of La Barge, and in front of the thrust an anticline was developed in the rudaceous Almy. On a probable erosion surface, the Knight formation (300 ft.), of soft red and grey shales and sandstones, was next deposited. The Green River sandstone and shales (700 ft.) conclude the Tertiary, and show gentle arching, probably due to differential compaction.

The oil of the La Barge field appears to have migrated from the Upper Cretaceous into the anticline of basal Eocene under the post-Almy thrust-plane. S. N.

206.* Correlation of Cross' La Plata Sandstone, South-Western Colorado. M. I. Goldman and A. C. Spencer. *Bull. Amer. Ass. Petrol. Geol.*, September 1941, **25** (9), 1745–1767.—The Upper Jurassic La Plata sandstone described by Cross in 1898 is taken to consist of five distinguishable units: (1) Entrada sandstone, yellowish to red in colour, massive, partly cross-bedded; (2) Pony Express limestone (maximum 15 ft.), dark grey to black, bituminous, discontinuous, and variable; (3) Bilk Creek sandstone (about 20 ft.), topped by 1½–2 ft. calcareous sands with nodules of red chert—"Carnelian sandstone"—recognizable, however, without chert; (4) Wanakah marl (50–100 ft.), argillaceous and sandy beds, characterized by concretions of barytes and by deposition of layers of a dark green mineral, either chloritic or glauconitic, on red chert; (5) Junction Creek sandstone (up to 500 ft.), whitish, with considerable rounding of grains and æolian false-bedding. (2)–(5) belong to the Morrison formation.

Two problems are tackled—namely, to find the relations of the units to one another, and to correlate them with related beds of South-Eastern Utah and Northern New Mexico.

In Southern Utah the Bluff sandstone belonging to the Morrison is taken as equivalent to the Junction Creek beds. The Todilto limestone of Todilto Park is not considered to represent Pony Express, since it is overlain by Novayo sandstone. But a limestone of the name Todilto in the north-west corner of New Mexico is accepted as equal to Pony Express, since it is succeeded by beds similar to Wanakah marl and lies on Entrada sandstone. A section on the Cimarron river, New Mexico, is suggested as

synchronous with the Colorado section, but sideritic sandstones seem to occur at a horizon above the top of the Junction Creek and below overlying Morrison sandstones.
S. N.

207.* Well-Logging by Radioactivity. W. L. Russell. *Bull. Amer. Ass. Petrol. Geol.*, September 1941, **25** (9), 1768–1788.—Since electric logging is a comparatively recent development, many cased and cemented wells have never been accurately logged. Because electric logging is limited to uncased holes, logging by radioactivity is the only known method of making lithological records through the casing and cement. The gamma rays used in radioactivity surveys are produced chiefly by the members of the uranium–radium and thorium series, and by potassium. Gamma rays from potassium are particularly penetrating; and shales, since they have more potassium than sandstones and limestones, are found to have relatively high radioactivity. Of the igneous rocks the light-coloured acidic rocks are most radioactive, while the heavy basic rocks are least so.

The instrument, which is lowered in the well, consists of a metal cylinder, the lower part of which (*i.e.*, ionization chamber) contains a gas under pressure. The gamma rays ionize the gas and decrease its resistance to the passage of an electric current, so that the current passing through the ionization chamber indicates the relative amounts of radioactive material in the formation surveyed. The current, after amplification, operates an automatic pen-recorder, which plots the log in the field while the survey is in progress.

At present these logs are used chiefly to determine the position of the producing sands behind casing, in order that the pipe may be perforated to drain them most effectively. Other applications are for determining the amount of sample lag, mapping subsurface structure for deeper drilling, making correlations and cross-sections, and for surveying potash deposits. A similar process may be employed in making radioactivity surveys at the surface and in mines.
J. T.

208.* Pre-Cretaceous Sediments in Cordillera Oriental of Colombia. P. A. Dickey. *Bull. Amer. Ass. Petrol. Geol.*, September 1941, **25** (9), 1789–1795.—On the east side of the Cordillera Oriental, the Quétame Series, with Carboniferous fossils, south-east of Bogota, and a shale of Onondagan age (Lower Devonian), at Floresta, have already been recognized as Palæozoic. Great upthrusts are common, like that west of Santa Rosa (Boyacá), but here the eastward section to Floresta appears to be normal, and includes: Tablazo limestone and shale (Middle Cretaceous); La Paja shale and Rosa Blanca limestone and shale (Lower Cretaceous); the Girón Series (? Jurassic or Triassic), comprising red-beds not less than 1000 in. thick and forming much of the western face of the Cordillera; Floresta shale (Lower Devonian); and, near Corrales, metamorphic rocks with igneous intrusions.

Graptolites have been reported, but without confirmation, on the west side of the Magdalena valley, where Philip Merritt's Suratá Series, with productids, is succeeded by his Bocas Series, containing thin, metamorphosed coals. Phyllites, probably Palæozoic, outcrop in several places, and at Meseta de Los Santos appear to underlie the Girón, although the actual contact may be faulted.

In the eastern part of the area, where the Girón is absent, the Cocuy sandstones are not of Girón age, but seem to be equal to the Lower and Middle Cretaceous limestones and shales of the west.
R. C. W.

209.* Photogeology. H. C. Rea. *Bull. Amer. Ass. Petrol. Geol.*, September 1941, **25** (9), 1796–1800.—It is argued that in geological mapping of a new area, most rapid progress is made by first preparing aero-photographs overlapping at least 60% at the sides, 30% at the ends, and on a scale of 1 in. to about 1650 ft. These will usually show exposed outcrops, obvious dips, possible faults, and will distinguish reflecting values of contrasting rocks and soils. Different types of natural vegetation and cultivation, drainage patterns, watersheds, reservoirs, quarries, and railways are also represented. The photos may be studied stereoscopically, and should be interpreted from the geomorphological—see Lobeck's text-book—as well as the geological point of view. Areas of complication can usually be picked out at once.

Salt domes have been located from anomalous drainage patterns, and mud-volcanoes

in dense jungles by means of a "timber halo." Ancient stream-courses filled by younger deposits are marked by vegetation and soil changes. Kelp adheres to undersea outcrops of Monterey shale, so as to delineate the Ellwood anticline, off Santa Barbara, California. Lodes and igneous patterns are also often made clear. Where loess, wind-blown sand, or glacial deposits provide a covering, photogeology encounters the same difficulties as normal field-mapping. A. L.

210.* Crude Oils and Stratigraphy in Parts of Oklahoma and Kansas. L. M. Neumann, N. W. Bass, R. L. Ginter, S. F. Mauney, C. Ryniker, and H. M. Smith. *Bull. Amer. Ass. Petrol. Geol.*, September 1941, **25** (9), 1801–1809.—In South-Eastern Kansas and North-Eastern Oklahoma, oil-pools in Burbank sand extend to form a curving belt, 150 miles long and 10–20 miles wide. The sands are hummocks with flat bases, and represent sand-bar accumulations of the Upper Carboniferous sea. In thirty-seven pools crude oils of similar composition are found. The only noteworthy variation is a slightly greater residuum in Oklahoma oil, with a perceptibly higher A.P.I. gravity than in the Kansas oils, due to a loss of light hydrocarbons over a long period. That the source-beds had a limited vertical extent within the Cherokee shale is indicated by the fact that the Rock sand, 50 ft. above the Burbank, and the Bartlesville sand, 100 ft. below it, yield different types of oil. It is likely that the oil originated in the organic sediments deposited in swamps behind the sand-bars, the thickness of these sediments usually not exceeding the height of the "sand-hills." The oil may have formed under pressure from later Pennsylvanian deposits. Structural movements which formed local anticlines did not affect the composition of the oil; neither did the tilting of the Prairie Plains homocline, nor recent differential erosion, since in Woodson County, Kansas, at 350–400 ft. below sea-level and at a depth of 1400 ft., the oil is similar to that in South-Eastern Butler County, at 1300 ft. above sea-level and under a cover 2700 ft. thick. A. L.

211.* Cementing Materials in Sandstones and their Probable Influence on Migration and Accumulation of Oil and Gas. W. A. Waldschmidt. *Bull. Amer. Ass. Petrol. Geol.*, October 1941, **25** (10), 1839–1879.—In a study of sandstones from the Minnelusa (Upper Carboniferous) to the Mesaverde (Upper Cretaceous) of the Rocky Mountain region, two general groups of cementing materials have been recognized: (1) argillaceous matrix, (2) minerals crystallized from solution. Argillaceous material is most abundant from the top Sundance (Jurassic) upwards, and, as in the Dakota and Cloverly, Frontier and Second Wall Creek (Colorado Group, Cretaceous) and Mesaverde (Montana Group) sandstones, often prevents solution of grains at points of contact, so that interlocking is absent or only partial; and consolidation is chiefly due to pressure, indicated by distorted mica-flakes, and to silicification which may make the matrix abnormally anisotropic. In some crystalline matrices the cement is quartz, or occasionally calcite alone; or initial quartz may be followed by one or more, in different orders, of the following: dolomite, calcite, anhydrite. Pressure of later deposits leads to solution of sand-grains at points of contact, with almost immediate reprecipitation of quartz, either in optical continuity on sand-grains or as independent crystals. Dolomite acts as a binding material in the Second Leo, Leo, and Converse sandstones of the Minnelusa, and in the Sundance. The dolomite follows quartz and, like the latter, is evenly distributed, so as to fill pore-spaces between smaller grains, but leaving some voids among coarser grains. With the exception of the Lakota (Lower Cretaceous) and the lower Dakota and basal Cloverly (base of Upper Cretaceous), calcite was found in all sandstones from the Sundance upwards, and took the form of anhedral grains. Foraminifera and limestone fragments are probably dissolved with rising temperature and pressure, and solubility is increased by decomposition of organic material and accompanying formation of carbonic acid and ammonium carbonate. Additional carbonates are obtained from ground-water, and precipitation in voids follows on release of pressure or fall of temperature. Sands originally rich in carbonates finally show sand-grains completely isolated in a calcite and/or dolomite matrix. Appreciable anhydrite, in poorly to well-cleaved crystals with one to three straight sides, is found in the Tensleep, Converse, and Leo (Upper Carboniferous) and in the Third Sundance. It is the last mineral to crystallize, usually following quartz and dolomite, rather than calcite. In fact, a sequence of quartz and calcite is characteristic in the Jurassic and Cretaceous sandstones, whilst

quartz, dolomite, and anhydrite are confined to those between the Bell (Pennsylvanian) and the Sundance.

Non-argillaceous sandstones in which recrystallized quartz is the only important precipitate tend to have relatively high porosity and permeability. They may be very rigid, due to partial interlocking of grains and to bridging of gaps by recrystallized quartz—*e.g.*, parts of the Dakota Sandstone. Argillaceous material and calcite both contribute to reduce porosity, especially where indigenous carbonate material is recrystallized under pressure into intergrown calcite grains. These factors are important in oil migration, which is also promoted by pressure due to volume increase when minerals, like anhydrite, are precipitated from solution. If water contains droplets of oil, from organic decomposition, too small to coalesce under static conditions, these are likely to unite when moved through sand, as in Meredith's process for sand-filtration of emulsions. The coalesced oil no doubt follows the water to low-pressure areas. The water may by-pass the oil, and, if it contains calcium carbonate, deposit the latter as a seal where there is marked release of pressure in tensional parts of anticlinal folds, in joints, in faults, and near the surface.

In a closed system increase of pressure due to crystallization may cause gas to be absorbed by oil and water. To this much of the initial high pressure in oil-fields may be due. Crystallization around an oil area may also so isolate it that during production the pressure may fall to zero, or below it. This is expected to happen in parts of the Sundance sands. In the Dakota sandstone, however, which has more uniform porosity, encroachment of water will maintain pressure. A. L.

212.* High-Pressure Yates Sand-Gas Problem, East Wasson Field, Yoakum County, West Texas. A. S. Donnelly. *Bull. Amer. Ass. Petrol. Geol.*, October 1941, **25** (10), 1880–1897.—Gas is found near the top of the Yates sand (Permian) over a large area of the Wasson Field, West Texas. In the north-north-east axis it is 92½–97% nitrogen, the remainder being mainly methane. It seems to be completely sealed in by local cementation. Pressures up to 2800-ϕ, but averaging 1800-ϕ, have given trouble by unloading drill-holes and by blowing off the mud-cake on red beds, so that the water in the latter escapes with accompanying erosion and bridging of the well-sides. The tight place is approximately 120 ft. below the top of the Yates, where, against a solid stratum of anhydrite, the casing is dented in a sharp kink. This is done either by beds sloughing, or by movement of the anhydrite itself when above and below it salt and sand are dissolved and washed out. A deeper "air" may also be met with in porous dolomite or sandy beds at the top of the Yoakum "Brown lime." By some this is ascribed to downward migration of Yates "air" following caving of overlying red beds in holes, but Alden Donnelly thinks it is of separate origin.

One precaution is to drill 11-in. holes, so increasing the volume of the hole and decreasing the possible velocity of the mud column. High-carbon-content steel may also be used in casing opposite the zone of collapse. Pulverized salt should be added to the drilling fluid before salt-beds are reached, so as to prevent solution of the walls. Moreover, a saturated salt solution 11 lb./gal. allows the "air" to bubble through in cases where a mud slurry of the same density is erupted. The "air" pressure reaches a maximum of 18 lb./gal. If a bit is changed at an unsuitable place it is possible for a bridge to form and for pressure to build up below it, followed by a break through with terrific water-hammer. Such outbreaks have been controlled by means of Baroid. The "air" horizon must not be penetrated while red beds are open. The string of casing should be secured in a seat of anhydrite, and the "air" horizon then be squeeze-cemented. "Stub" strings for permanent control of the gas may also be set. A. L.

213.* South Cotton Lake Field, Chambers County, Texas. J. M. Wilson. *Bull. Amer. Ass. Petrol. Geol.*, October 1941, **25** (10), 1898–1920.—A blanket torsion-balance survey over a large section of Chambers County in 1934 indicated a prominent minimum, centred slightly north of the present producing area. The dry well, Lawrence No. 1, was then drilled and abandoned at the depth of 7005 ft. It had, however, sufficient showings to justify drilling the Lawrence No. 2, which was also abandoned at a depth of 7300 ft. The area was then surveyed with the reflection seismograph, using the continuous profile method. As a result of this work, the location for the discovery

well was found, and subsequent surveys showed the true picture of the structure, a faulted dome elongate east to west.

The three producing sands are the *Marginulina*, Frio No. 1, and Frio No. 2, with an average of 7½ ft., 10 ft., and 5 ft. effective sand, respectively. These occur in the Oligocene within an interval of 100 ft., and the average total depth of wells is 6500 ft. The maximum producing area may be about 1200 acres. At present there are fifty-one oil wells and two gas wells in this area, and development is almost complete. As at January 1, 1941, the total production derived from three producing sands was 1,573,400 brl.

The Vicksburg or *Textularia warreni* zone has been penetrated at 8301 ft. J. T.

214.* Relation of Organic Matter to Colour of Sedimentary Rocks. H. W. Patnode. *Bull. Amer. Ass. Petrol. Geol.*, October 1941, **25** (10), 1921–1933.—After crushing and drying at room temperature, powders from more than 3000 samples of grey sediments were examined for reflectivity. Smooth surfaces were obtained, and these were compared with surfaces of known reflecting power in a reflectometer. In comparison with magnesium oxide, taken as 100% and lampblack as 2% reflective, it was found that results for the rocks varied from 8% to 66%. Nine-tenths were between 18% and 49%, and half between 25% and 35%. The nitrogen and the reduction number of the samples were also determined as rough indices of organic content which is not directly measurable. The reduction number is the number of c.c. of 0·4 normal chromic acid that is reduced by 100 mgm. of sediment under standard conditions. In general, dark sediments with low reflection give high reduction numbers, and highly reflective sediments have low reduction numbers. Dark sediments have also relatively high nitrogen content. The average reduction number is about 1·00; and the ratio of 100 times the nitrogen content to the reduction number is called the nitrogen-reduction ratio. The average reduction number of samples having a nitrogen-reduction ratio less than 5·0 is consistently greater than the average reduction number of those having a nitrogen-reduction ratio greater than 5·0. Sediments of like colour are relatively poor in nitrogen when the reduction number is high.

For a given reflectivity, coarse sediments have a smaller reduction number, and therefore contain less organic matter than fine sediments. Finely divided calcium carbonate probably causes limestone and chalk to be more reflective than clastic sediments with equivalent organic content. Ferric and ferrous compounds are also important. The average reduction number for Californian deposits is greater than that of Mid-Continent sediments of the same colour. This may be due to one or more causes—*e.g.*, texture of samples and nature of organic constituents.

Colour values from reflectometer work can be used to supplement other forms of well-logs. A graph of reflectivity recordings for the Upper Devonian shale section, from the top of the Onondaga limestone to the base of the Berea Sand in West Virginia, is provided, and also a graph of the reduction numbers to show the close relationship between the two. A. L.

215.* Migration of Oil from Arbuckle Limestone into Chattanooga Shale in Chetopa Oil Pool, Labette County, Kansas. G. E. Abernathy. *Bull. Amer. Ass. Petrol. Geol.*, October 1941, **25** (10), 1934–1939.—The Chetopa Pool, in South-Eastern Kansas, lies at or near the unconformable contact of the Arbuckle limestone (Ordovician) with the Chattanooga shale (? highest Devonian). Over most of the field the oil is in porous dolomite and is separated by a "cap rock" of denser, more cherty dolomite from the 8–20-ft. black, fissile shale. Where the "cap rock" is absent, oil has migrated into the shale, which is less porous than the Arbuckle, but is waterless, and probably has many joints at points of folding. The oil has some of the lighter fractions (gasoline) common in most crude oil of the region. Associated water has a very low content of dissolved solids—1583 p.p.m.—mainly sodium chloride and bicarbonate. A. L.

216.* Carboniferous Foraminifera of the Samara Bend [U.S.S.R.], by D. Rauser-Černoussova, G. Beljaev, and E. Reitlinger. Summary by S. W. Muller and H. G. Schenk. *Bull. Amer. Ass. Petrol. Geol.*, October 1941, **25** (10), 1943–1949.—Foraminifera have been identified from a complete section of Carboniferous in a 1471-m. well, near Syzran, on the Volga. Below 1099 m. Devonian *Endothyrae* were recognized.

In the Lower Carboniferous, in beds taken as Tournaisian, the species are few (as in England), and include *Endothyra* aff. *bowmani*, *E.* sp., *Hyperammina elegans*, and *Spirillina* sp., while the Visean yields characteristic species—*Staffela struvei*, *E. crassa*, *E. globulus*, *H. vulgaris*, and *Archaediscus karreri*. These are most numerous in the Middle Visean, in which special levels are marked by *Cribrospira panderi*, *E. omphalota*, and *Samarina operculata*. Middle Visean, also (much as in England), sees the largest *Endothyrae* appearing in greatest numbers. In the late Visean of Russia the microfauna becomes impoverished. The Transition Beds, between Visean and Middle Carboniferous, show *Bradyina cribrostomata*, similar to *B. potanini* Ven. from Mongolia, and *Climacammina* acting as rock-formers. In the Middle Carboniferous, fusilinids become dominant with genera like *Fusulinella* and *Schubertella*; *Fusulina* and *Wedekindellina* come in later than the other two; spheroid staffelids are also important. The Upper Carboniferous provides the lowest stratigraphic occurrences of *Triticites* and *Quasifusulina*.

The Russian Lower Carboniferous corresponds with the Mississippian in whole or part. Middle Carboniferous seems to be equal to Lower Pennsylvanian, Upper Carboniferous synchronizing with the American marine Upper Pennsylvanian.

A. L.

217.* Oligocene Stratigraphy of East White Point Field, San Patricio and Nueces Counties, Texas. P. F. Martyn and C. H. Sample. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 1967–2009.—Subsequent to the discovery of oil in the 5600-ft. sand (Frio) in 1938, some 240 wells have been drilled, and nearly 5,500,000 brl. of oil produced. The basis of this stratigraphic study has been the correlation of sand and shale intervals by interpretation of electric logs, with the help of accurate sampling, isopach maps, and palæontological information. The beds considered are those between the 4100-ft. sand (zone A) at the top of the Middle Catahoula and the 5600-ft. sand of the Frio, which is the principal oil-producing zone. They are subdivided, in descending order, into six zones: Zone A, the 4100-ft. sand, is a near-shore deposit of a regressive sea; Zone B, 4500-ft. shale, was deposited under quiescent conditions, with little continental or structural deformation; Zone C, *Heterostegina* sand, 4900 ft., shows progressive thickening westward, and was deposited by a sea transgressing eastward from the ancient gulf of Mexico which lay to the south-east of the oil-field area; Zone D, 5300-ft. shale, thickens from east to west and is a lagoonal deposit following the drowning of the ancient Nueces valley; Zone E, 5400 ft. sand, thins from west to east and shows terraces, slopes, and meander scarps which display typical features of degradation and planation common to the erosional cycle of a river in an area of uplift, three movements being suggested by the terraces of the ancestral Nueces river which lay to the west of the producing area; Zone F, 5500-ft. shale, thickens towards the north-west, and was deposited as an accompaniment to continental downwarping and tilting.

The alternation of sand and shale suggests shallow-water conditions. The unconformity at the top of the 5400-ft. sand (Zone E) marks the top of the Frio, and is important stratigraphically. A geologic correlation chart is included in the paper, which, in addition to electric logs and isopach maps, contains isometric perspective block diagrams.

R. C. W.

218.* Marine Sedimentation and Oil Accumulation on the Gulf Coast. 1. Progressive Marine Overlap. D. S. Malkin and D. A. Jung. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 2010–2020.—Progressive marine overlap provides ideal conditions for oil formation, migration, accumulation, and production; a transgressive sand is a lithological unit, composed of graded sands passing down dip into finer sands, sandy shale, and shale, and passing laterally seawards into finer sediments and shale which act as a good impervious seal. The numerous overlaps in the Gulf Coast Tertiary are found in Upper Wilcox, Cockfield, Marginula-Frio, and Lower Miocene sands, being formed by minor fluctuations of sea.

The Cockfield sand (Eocene) is studied with the aid of electric logs, and shows almost ideal conditions. One point stands out: the top of the Cockfield formation has been hitherto regarded as being marked by the foraminifer *Nonionella cockfieldensis*, but on comparison with sections drawn from electric logging, this is found to be incorrect. Thus, the Cockfield sand-body represents a lithological unit, and not a

time unit. It is diachronous. In dealing with transgressive sands, it is to be expected that the palæontological index-fossil will be found above the sand in downdip wells, if a fossil is used which was not limited to one environment. Thus, the occurrence of palæontological markers, representing time units, must be at variance with the electric loggings of the sand tops. R. C. W.

219.* Activity in Texas Panhandle Maintains Upward Trend. H. F. Simons. *Oil Gas J.*, 18.12.41, **40** (32), 14.—The Panhandle is generally considered as one large field having several producing zones, and it has the largest area of any oil- or gas-field in the world. For more than fifteen years it has been a major influence from an oil production standpoint, and has given about 2,000,000 brl./month for the past six years. To date it has produced more than 400,000,000 brl. of oil, while the present reserves are about 700,000,000 brl.

The oil-producing area varies from 1 to 10 miles in width, whereas the gas area ranges from 10 to 40 miles wide. It lies on the northern flank of the buried Amarillo mountains. Oil comes from three main horizons—the white and brown dolomites, and the granite wash. The pay-zones are commonly 75–150 ft. thick, and in general the oil is produced from younger beds in the north than in the south.

5200 wells are now listed as producing oil. The allowed production has been rising during 1941, and on a 30-day month basis has averaged 85,000 brl./day, although it is believed that the field could produce from 150,000 to 300,000 brl./day without waste.

The field is well situated with regard to pipe-lines and refineries. The 40° A.P.I. crude is all sour. There are thirty-eight gasoline plants and thirty carbon-black plants in the area.

The completions per month are listed, and a table gives the system of determining well allowables. G. D. H.

220.* World-Wide Oil Possibilities. W. V. Howard. *Oil Gas J.*, 25.12.41, **40** (33), 81.—The petroleum possibilities of the world outside the U.S.A. are much greater than those of the U.S.A., and some districts may eventually be as rich per unit area. A series of maps has been prepared in which the continental areas have been subdivided according to the relative likelihood of finding oil in them. The most favourable areas are those where oil and gas are now found, either as seepages or as fields. They comprise areas with sediments of sufficient thickness to permit the existence of several reservoir horizons. The less favourable areas include remote areas about which little is known, areas with a thin cover of sediments and a lack of definite structural trends, and areas which may prove too strongly folded or where potential reservoirs are overlain by great thicknesses of continental deposits or ice and snow. Areas considered "impossible or improbable" are those with strongly folded mountain ranges, great masses of intrusive igneous rocks, or pre-Cambrian rocks.

The western hemisphere and the U.S.S.R. contain the largest areas of potential oil land.

South America.—The mountain ranges are so disturbed as to have removed the chances of finding oil, but between individual chains and in the area between the shield and the mountains there are great thicknesses of sediments providing potential reservoirs. The four most favourable belts are the trough between the Andes and the shield, the Pampas region, the coastal plain west of the Andes, and the coastal plain east of Brazil. The sub-Andean trough has production at both ends—in Trinidad and Eastern Venezuela in the north, and in Bolivia and the Salta–Jujuy region of Argentina in the south. Recently production has been found in the centre in Eastern Peru. The Comodoro Rivadavia and Mendoza fields are in the Pampas region. In the Pacific Coastal plain is the Ecuadoran and most of the Peruvian production. The possibilities are problematical at present in the Atlantic coastal area. The great thickness of alluvium has caused the Amazon valley to be classed as less favourable.

Mexico and the Caribbean.—Three types of petroliferous areas are known in this region—the coastal plain of Mexico and Yucatan, the intermontane valleys of the Andes, and patches and strips of sedimentary rocks flanking mountain chains or fragments of chains. All three types have been partly prospected, and two of them yield important amounts of oil. In the coastal plain area are some salt domes, but

these are of little importance at present. The main production has come from great limestone "highs." Near the Rio Grande small amounts of oil and large quantities of gas come from the Tertiary. Yucatan is virtually untested. The intermontane valleys provide the oil of Colombia, Venezuela, and Trinidad.

Europe.—The areas favourable for prospecting are the foreland of the northern chain, the Russian platform, the North German plain, and irregular areas of little disturbed sediments caught up within loops and between chains of the Tertiary mountains. In the foreland of the Alpine chains there are showings in front of the Pyrenees, the new fields of the Vienna basin, the Polish and Rumanian fields, and the Maikop, Grozny, and Baku areas of the U.S.S.R. These areas are progressively richer towards the east.

In spite of the discovery of important fields, the Russian platform area is virtually untested. The North German plain, including the Rhine Valley, contains small oil deposits, of which many are associated with salt masses. The intermontane plains yield small quantities of oil in Italy, Albania, and Hungary.

Asia.—Some of the areas most favourable for prospecting are extensions of two European zones. The foreland belt crosses the Caspian from Baku, and is found in the Fergana region of Southern Siberia. The Russian platform passes south of the Urals into the Aralo–Caspian area, where the Emba district provides important oil production. The foreland of the southern looped chains is productive in North-west India and Burma, and fragments of the sedimentary rocks protected from collapse by close proximity to the backbone of the island festoons give oil in Sakhalin, Japan, Taiwan, and Borneo.

In Szechuan and Shan-si there are seeps and some production. The Arctic and Lena areas are practically unknown, but the presence of slightly folded Tertiary rocks is a matter of interest.

Africa and the Near East.—Probably the only areas which afford a possibility of large oil production are along the northern margin of the continent in the intermontane valleys of the Atlas region, and in the foreland of the Zagreb mountains of Iran. In the former area there are some small fields and many seeps. The fields of the foreland region of the Zagreb mountains form the most important group yet found in continental Asia, and recent work in Iraq, Bahrein, Kuwait, and Saudi Arabia has extended the petroliferous zone away from the mountains.

The coasts of Mozambique and Western Madagascar appear to have the best possibilities for production in Africa proper; the bulk of the continent is unlikely to yield oil. Of secondary importance are the Lake Chad depression, the Niger embayment, and the Sahara–Sudan area.

East Indies and Australia.—The fields of the Netherlands East Indies differ from the other major fields associated with the southern looped chains of the Alpine–Himalaya systems in that they are situated in the backland rather than in the foreland. Australia and the associated island arcs have few oil possibilities, and the best of these are in down-faulted marginal blocks and in the depression between the shield and the Australian Alps. In the sediments flanking the mountains in New Zealand and New Guinea there are oil indications, but no important oil production has been obtained.

Dominion of Canada.—The area offering the best oil possibilities is the Plains region or the valleys of the Mackenzie and Saskatchewan rivers. There are the sharp structures of Turner Valley and broader folds, as well as the tar sands of Athabaska. The prospects of Ontario are not good, and the same appears to be true of Gaspé. New Brunswick has shallow oil and gas production, and extensive deposits of Mississippian oil shale. G. D. H.

221.* Venezuela's Oil Industry Exceeding Pre-War Output. L. H. Figueredo. *Oil Gas J.*, 25.12.41, **40** (33), 90.—From the beginning of 1941 there has been an almost continuous increase in Venezuela's oil production, from 489,595 brl./day to 681,050 brl./day. The 1941 production will probably exceed 220,000,000 brl., almost 33,000,000 brl. more than in 1940. Crude oil exports for 1941 are expected to be about 194,000,000 brl., and refined product exports 25,000,000 brl.

Four new fields were being developed in Eastern Venezuela in 1941. Two wells have been completed at Santa Barbara in Northern Monagas with about 1200 brl./day of 30–32° A.P.I. oil. In the Leona region, north-east of Oficina, eight wells have

been brought in, with an average of 1100 brl./day of 26–30° A.P.I. oil. One well has been completed at Santa Rosa, east of El Roble. It is capable of giving 1800 brl./day of 42° A.P.I. oil. On concessions adjoining Santa Rosa and El Roble two producing wells have been drilled which averaged 1150 brl./day of 39–48° A.P.I. oil, in tests.

Three of the five wildcats started in Eastern Venezuela in 1941 have been abandoned. Substantial oil showings have been encountered in Mercedes 1 in Central Venezuela, and this promises to be the first commercial producer in that region.

A table shows the production by fields and companies in the January–September periods of 1940 and 1941. G. D. H.

222.* Shell's Discovery on Yondo Block is Colombian Feature. E. Ospina-Racines. *Oil Gas J.*, 25.12.41, **40** (33), 94.—Casabe 1, a wildcat on the Yondo concession near Barranca Bermeja, encountered several oil horizons in drilling to 7150 ft., and one of them has shown a potential of about 500 brl./day. A second well is to be drilled on the crest of the structure. Cimiterra 1 reached the basement rock at 1091 ft., and has had showings of heavy oil. A well on the Gutierrez concession entered the Cretaceous at 5861 ft., and has been taken to 7800 ft. without any showings being reported.

At the beginning of October on the Barco concession, Petrolea No. 99 was at 1395 ft.; 1 Sardinata was at 4717 ft., having given 150 brl./day on test; 1 Socuavo had reached 9850 ft.

Of twenty wildcats since 1937, only one has shown promising results—1 Casabe.

In the first nine months of 1941 the Colombian oil production was 9% below that for the corresponding period of 1940. No drilling has taken place on the Infantas structure since 1932, and the La Cira structure, with 681 wells, has been completely drilled and defined. The Petrolea structure has 163 wells and the Rio de Oro field seventeen.

About a sixth of the total area of Colombia is classified as prospective oil land, and of this half is difficult of access, being east of the Eastern Cordillera of the Andes.

Tables give the area of prospective oil land in the different districts, the areas of the concessions, and the oil production in the first nine months of 1940 and 1941. G. D. H.

223.* Argentina's Crude Output Reaches 21,755,000 Brl. Anon. *Oil Gas J.*, 25.12.41, **40** (33), 99.—It is estimated that Argentina's 1941 output will be 21,735,000 brl., a rise of 5%, the bulk of the increase having come from Mendoza. 35% of the output is from Comodoro Rivadavia. Twenty-nine exploratory rigs were in action in 1941.

Efforts to develop deeper oil-pays below those previously known in the El Tordillo area were unsuccessful in a well drilled to 7750 ft. In the Bella Vista zone, 8 ml. north-east of the town of Comodoro Rivadavia, a well taken to 4370 ft. had only slight oil-showings. There were five unsuccessful wells in the Golfo de San Jorge, two stopping in basalt. A large gas well was completed in the Santa Cruz area, giving 12,350,500 cu. ft./day from 2713 ft., with a closed-in pressure of 940 lb./in.². No further showings were found down to 4756 ft. Eleven miles north-west of the Plaza Huincul region a well encountered oil- and gas-shows. A second well had similar results. A new discovery was made at Portezuelo, 20 ml. west of Plaza Huincul. Four other wells in Neuquen were abandoned.

Substantial production was obtained in a well in the Tranquitas field. Only small showings were found in a well on the western flank of the Santa Barbara anticline in Jujuy. Extensions were made to the Tupungato field, and to the north-west considerable oil was found, without, however, sufficient pressure to give flow. At Barrancas a producer was completed in the Lunlunta pay, and on the north dome, five miles north of previous production in the Lunlunta field, two good oil wells were brought in. A gas well was drilled at Pampa Palauco, north of Ranquil.

Considerable geological and geophysical work was carried out in 1941.

A map is appended, and tables show the production by districts for the first eight months of 1940 and 1941, the total output during the first eight months of the years 1937–41, and the distribution of the production between the Y.P.F. and private companies in 1940. G. D. H.

224.* Survey of World Oil-Fields. Anon. *Oil Gas J.*, 25.12.41, **40** (33), 117.—The number of producing wells, daily average production, producing depths, gravity and

base of the crude, outlet, age of field, and number of wells drilling are tabulated for the various districts of the oil-producing countries. G. D. H.

225.* **Cretaceous Tested West of Petrolea Production.** Anon. *Oil Gas J.*, 25.12.41, **40** (33), 132.—Active oil seeps at La Petrolea attracted attention, and in 1906 a small refinery was built to refine seepage oil. Intensive geological work was not undertaken on this, the Barco concession, until 1931, and drilling began in 1933. At present the major producing area is the North Dome, with 101 operating wells. A small well is productive on the South Dome, and two small wells yield oil at Carbonera.

The Upper Cretaceous limes are being tested in Socuavo 1, which encountered metamorphics at 9850 ft. Other wells are expected to test the Tertiary and Cretaceous, the latter being productive at Petrolea. The Carbonera wells obtain oil from strings of Tertiary sand, but Tres Bocas 1, Socuavo 1, and South Sardinata 1 failed to obtain commercial production on the Tertiary sands.

A 12-in. pipe-line conveys oil from the Barco concession to Covenas. The production in 1940 was 4,207,770 brl., of which 3,964,921 brl. was transported by pipe-line to the coast. G. D. H.

226.* **Blue Goose Development May Open Amazon Industrial Era.** T. P. Sanders. *Oil Gas J.*, 25.12.41, **40** (33), 137.—The Agua Caliente structure is about 6 ml. west of the Rio Pachitea and some 10 ml. from where the Rio Pachitea enters the Rio Ucayali. It is ringed by sandstone dipping at 14–25°, and runs north-west–south east for about 15 ml. The closure is estimated at 3500 ft. A smaller structure lies 20 ml. to the south-east. The beds are of Cretaceous age, the outcropping Sugar sandstone rests on the limestones, marls, and shales of the Chonta series. The oil-bearing beds are in the Agua Caliente series of sandstones and shales, which are of Upper Middle Cretaceous age.

Six wells have been completed, although two have unsatisfactory bottom-water shut-offs. A second oil sand has been penetrated but not tested in one well. About 90 ft. of oil sand occur in the interval 1020–1174 ft. The well gave 750 brl./day on a ¼-in. choke, whilst a short test on open 3-in. tubing gave oil at the rate of 2500 brl./day. Other wells have given oil at the rate of 42–100 brl./hr. The 45° A.P.I. oil is accompanied by little gas.

The six wells have proved an area of about 1 sq. ml. Little oil has been produced, owing to the lack of outlet.

A short account is given of the history of development, living conditions, and the problems involved in exploiting this remote field. G. D. H.

227.* **Mexico's Oil Production Suffers Further Decline.** Anon. *Oil Gas J.*, 25.12.41, **40** (33), 137.—Owing to the lack of adequate finance and modern equipment, the Mexican oil properties have suffered some deterioration during the past few years. Drilling operations have declined more than 75% since 1934. Forty-four wells were completed in 1940, and there will be about the same number in 1941. The 1941 production will average about 117,000 brl./day, nearly 3000 brl./day fewer than in 1940. At the end of July 1941, fifteen wells were being drilled in Vera Cruz, eight being in the El Plan district, and seven in Poza Rica. Six wells were being drilled in the Ebano-Chapacao section of San Luis Potosi.

Of the Mexican production, 60–65% comes from Poza Rica, which has less than forty completed wells. The gas output is approximately 80,000,000 cu. ft./day, indicating a gas–oil ratio of about 10,000 cu. ft./brl.

Seven refineries are in operation, with a total crude capacity of 141,500 brl./day, and cracking facilities of 19,700 brl./day. In the first seven months of 1941 the exports to U.S.A. averaged 41,650 brl./day. G. D. H.

228.* **Drilling Shows Likely Prospects in Brazil.** E. de Carvalho. *Oil Gas J.*, 25.12.41, **40** (33), 154.—42·7% of Brazil has outcrops of the basement complex. Devonian beds occur at depth over a large area, and seem to have considerable oil prospects. They rest on the Silurian in much of Amazonas, and also occur south of the Amazon, at Tapajos south of Itaituba, in Mato Grosso, Sao Paulo, Parana, Santa Catarina, and Rio Grande do Sul. Carboniferous beds are not nearly so widespread as the

Devonian, occurring in Amazonas, Para, Sergipe, Baia, Sao Paulo, Parana, Santa Catarina, and Rio Grande do Sul. The Triassic, Jurassic, and Cretaceous are found in almost every State in Brazil. Immense beds of Triassic are seen in the eastern basin. The Cretaceous is found along the coastal belt from Baia to the Amazon, in the Amazon basin along the border of the Andes, and extensively in the central plateau. Tertiary beds are most common and best known along the coastal belt.

de Oliveira estimates that 492,650 sq. km. of the country fall into the category of having good oil possibilities; a further 2,335,850 sq. km. are of interest, and 934,250 sq. km. are of secondary interest.

The Brazilian laws do not encourage exploration. G. D. H.

229.* Vermilion in Alberta Gets Important Well. Anon. *Oil Wkly*, 29.12.41, **104** (4), 46.—Princeville 2 has been completed at 35 brl./day at a depth of 1797 ft. The Vermilion field now has nine producing wells, two flowing and seven pumpers. Two other wells await testing. G. D. H.

230.* Drilling Reduced in Final Month of Active Year. Anon. *Oil Wkly*, 12.1.42, **104** (6), 34.—In December 1941 completions in U.S.A. averaged ninety per day—a higher level than for any previous December except 1939. In July, August, September, October, and November 1941, completions were consistently around 100 per day. In 1941, 32,292 wells were completed, 1653 fewer than in 1937 and 1619 fewer than in 1920.

Tables show by States or districts the total rigs in operation on 1st January, 1941, 1st December, 1941, 1st January, 1942, and their status on 1st January, 1942; the completions for December 1940, and November and December 1941, with the details for December 1941; the cumulative completions for 1940 and 1941, with details for the latter year. G. D. H.

231.* Oil Producer Completed in Mulata Field, Venezuela. Anon. *Oil Wkly*, 12.1.42, **104** (6), 48.—Mulata 2, the first oil well in the Mulata field of Monagas, has given, on test, 570 brl./day of 34·7-gravity oil through a $\frac{3}{4}$-in. choke from two levels between 4590 and 4751 ft. A test of the upper zone alone showed 327 brl./day of 28·5-gravity oil through $\frac{6}{16}$-in. choke. Mulata 2 lies 1400 yds. south of Mulata 1, which was completed as a gasser showing 2,500,000 cu. ft./day through a 3-in. orifice.

It is expected that an area of several thousand acres will be developed in this field, which is at the extreme western end of the Amana River concession, and is on a line between the Santa Barbara and Jusepin fields. G. D. H.

232.* Lone Colombian Strike in 1941 Making 340–400 Barrels. Anon. *Oil Wkly*, 12.1.42, **104** (6), 48.—Casabe 1, reported to be the only successful wildcat drilled in the Magdalena Valley in 1941, has been completed for 340–400 brl./day on gas-lift, and is on regular production. G. D. H.

Geophysics and Geochemistry

233.* Recent Developments and Success in Geodynamic Prospecting. S. J. Pirson. *Oil Wkly*, 12.1.42, **104** (6), 20.—In ten months since the introduction of geodynamic prospecting seven wildcat or semi-wildcat wells have been drilled as a result of surveys made in or near regions surveyed. Three are commercial oil and gas producers, and one found an accumulation of 10,000 brl./acre, which was not recoverable economically. All the tests were in Northern Pennsylvania.

The geological requirements for an oil accumulation are a source-bed, trap, and cover rock, although these do not guarantee the existence of commercial accumulations, and even with a combination of the improved prospecting methods of geology and geophysics, successes in wildcat drilling do not exceed 25%. Part of the failure of these methods is a consequence of their being indirect.

The realization that oil-fields may be indicated by visible seepages or "micro-seepages" of hydrocarbons, and also by "micro-leakages" of gases through apparently solid ground, led to the investigation of soil air with some success, and later to the examination of the gases retained by soil particles.

It appears that soil sample concentrations of hydrocarbons are more influenced by soil adsorption characteristics than by the amount of gas leakage. The pattern of the leakage is a manifestation of the change in soil-adsorption properties resulting from leakage of oil-field waters. The halo pattern is generally associated with the edges of the fields, but does not necessarily mean the presence of an oil-pool, for only a small percentage of the haloes drilled have resulted in oil discoveries. The soil hydrocarbon distribution cannot be correlated with the depth of the source, and the patterns are permanent, not disappearing when the field is depleted.

Attempts have been made to measure the rate of gas leakage by permeation, diffusion, and effusion, and to apply it to the discovery of fields. According to theory and as measurement shows, the maximum rate of leakage is over the accumulation, and an actual case gives a maximum rate of leakage inside the "soil-halo."

In preparing for a geodynamic survey the first line of stations should be approximately at right angles to the expected geological trend, and about 1000 ft. apart, although for stratigraphic traps, which are often narrow, half this spacing is advisable. The line should extend ½–1 ml. beyond the edge of the land under consideration. The results of such a survey would be indicative of accumulations at depths up to 3000 ft. or more, and absence of anomalies of gas leakage would condemn the area. If the results are favourable, parallel lines of tests should be made 1000–2000 ft. from the first line. The results are more definite in their implications than are those of soil analysis.

The field work in geodynamical prospecting is simple. G. D. H.

Drilling

234.* Hardening Times for Casing Cementation. N. Healey and S. L. Pease. *J. Inst. Pet.*, January 1942, **28** (217), 1–14.—A discussion is made of the effects of various factors, such as time, water–cement ratio, temperature, acceleration, etc., on the hardening times of cement. The curves presented show that oil-well cements at present in use in Trinidad are a good deal better than is required. A. H. N.

235.* Progress in Drilling. Anon. *Oil Gas J.*, 25.12.41, **40** (33), 179.—Advances in drilling during 1941 are reviewed. No strikingly new achievement is reported. Types of portable rigs are briefly described. Methods used to raise these derricks vary widely. Hydraulic power, screws, or gin-poles and lines are most commonly employed. These derricks usually have their bases attached to the frame of a truck or skid, and this portion stays in place while moving. When it is desired to raise the derrick, the upper sections are bolted to the base and raised as a unit. When moving from location to location within a field, it is not necessary to take the derrick apart; it is simply laid down over the truck or skid and a trailer used to support the crown-block end. When moving over public highways, road regulations make it necessary to take the taller derricks apart in several sections.

Cementing and types of special cements are discussed. An innovation has been the bulk delivery of cement to the well when casing is being set. The cement is hauled in large covered trucks and trailers equipped with screw-feeds. This allows the cement to be fed into the hopper and a more even water–cement ratio maintained throughout the operation. Other improvements include those obtaining better bonds between cement and formation than was possible hitherto.

Mud-fluid problems are discussed. One of the most difficult of these—the maintenance of a low filter rate in the presence of salt—may be solved through the work done with gums (tragacanth, karaya, and ghatti), kelp (Irish moss), and starch. Because of the war, all except starch are becoming increasingly difficult to obtain, but the gums demonstrated a remarkable ability to reduce the water loss of salt-water muds.

It should be noted that raw starch will have no beneficial effects, but that the starch must be boiled with caustic soda. The starch is first mixed with water, caustic soda added, and the mixture heated with steam until a viscous, straw-coloured mixture results. The composition should be about 89% water, 10% starch, and 1% caustic soda. When only a small amount of starch is added, the viscosity and filtrate are increased, but further additions reverse the trend.

Slim-hole drilling, rotary speeds, and bit weights are reviewed. An interesting experiment is being conducted in California to determine the feasibility of using drill-casing. The casing is used for a drill-stem, and is then run in the hole as the oil-string to complete the well. The casing used has been 4½ and 5½ in. pipe, and no outstanding trouble was experienced with the threads. It should be noted, however, that this experiment was conducted in an area where the formations were relatively soft and the strain on the drill-pipe was light. Removable casing is briefly studied.

Reverse circulation is being more widely used for the completion of wells having a high or medium formation pressure. The circulating medium (oil) is forced down the casing and up through the tubing, the increased velocity obtained being sufficient to carry out even large pieces of steel. The bit has no water-courses, but a single large opening. By keeping pressure from the formation and minimizing exposure to water or mud, a better completion is obtained. There is also a saving in time, as a well can be completed in 46 hrs. if no shot is used, or 120 hrs. if a shot is placed.

Detailed rules for hard facing of tool-joints are given.

The paper is in both English and Spaniah. A. H. N.

236.* Difficulties of Completion in Central Louisiana. W. R. S. Jones and R. M. Sanford. *Oil Gas J.*, 1.1.42, **40** (34), 52. *Paper Presented before American Petroleum Institute.*—The greatest difficulties are due to the fact that the well walls consist of very soft "rotten" shales and argillaceous, unconsolidated sands. This condition makes it almost impossible to obtain a firm bond between the cement and the wall of the hole. A definite cause for subsurface failure is hard to establish absolutely, but it is generally accepted that this lack of bond causes more poor cementing jobs in the area than any other defect.

There is an unusually fine natural mud in the area, and very little artificial agents have to be added to the drilling fluid, with the possible exception of about 8 gal. of viscosity reducer/well to keep down the viscosity. The mud is maintained at about 28–30 sec. viscosity A.P.I. and about 10·2 lb./gal. After reaming down in preparation to running casing, only about 7 or 8 hrs. is lost before landing and cementing the string. Casing centralizers are always spaced above and below the producing sand, thus eliminating the chance of the pipe lying against the side of the hole. A casing programme in one of the fields concerned is detailed.

If gas and/or water are encountered, squeezing at the top of the pay and a squeeze job at the base of the pay are employed. This guards against possible migration of gas or salt water up or down the pipe to the oil-sand. It also helps to create an artificial break at the oil–water or gas–oil contact point. On these squeeze jobs the bradenhead method is used (one set of perforations at a time), but on various occasions a squeeze tool has been used when pressure greater than 2000 lb. was desired. Breakdown pressures on these formations vary from zero to 1400-lb. surface pressure.

Salt water mixed with the cement has been tried in several instances, but with comparatively poor results. The slurry tended to fluff up considerably, and, when set closely, resembled a porous sponge. The theory or practicability of the procedure has not been entirely abandoned. One service company in the field is at present experimenting with this idea, and hopes to arrive at some definite conclusion soon. It is thought there might be a solution of brine with just the proper amount of salt to produce a good slurry.

Four attempts to solve the problem of shutting off salt waters are described in detail. Temperature and gamma-ray surveys are used. A. H. N.

237.* New Type of Slim-Hole Rotary Rig. H. F. Simon. *Oil Gas J.*, 15.1.42, **40** (36), 33.—The rig is designed for drilling economically to 7500 ft. and beyond with 3½-in. drill-pipe, is entirely wheel-mounted, and can be assembled in a few hours after arrival at the location. Because the equipment will be moved less often than on shallower drilling, the actual hole-making operation was stressed in construction rather than the moving feature.

The entire rig is a departure from standard practice, as are many of the parts. This is the first rig mounted on wheels to be propelled by the drilling engines instead of being pulled or driven by a separate engine. It is also the first on which the carriage-frame serves as the frame for the hoisting machinery, the compounding

drive, and the engines. The 120-ft. mast, which can be used for pulling thribbles, is the first of that height designed with a base which comes within the highway limit of 8 ft.

The rig is equipped with supercharged drilling engine and with special air controls which have both an automatic and flexible speed regulation. There is only one jaw-clutch in the entire assembly, and this is really not used as a clutch, but as a shifting mechanism between the two sets of gears. All other clutches are of the friction type, the majority of them being air-actuated. The drilling rig is entirely chain-driven, the only gear being in the rotary table.

The derrick base, the method of handling the crown-block, and the provisions for raising the derrick are also unusual. The crown-block is described partly by the term "floating."

It is estimated that the rig may have to be moved between fifteen and twenty times a year. These figures indicate the importance of reducing the rigging-up time to the minimum. Normally rigs used to drill beyond 5000 ft. cannot be moved and rigged up in a day's time, most of them requiring 2 days before drilling of the surface hole is begun. The new rig is designed so that it may be moved a reasonable distance, rigged up, and put in operation in less than 8 hrs. This means that in a year's time it will be possible to drill an additional well over what could be drilled if conventional equipment were used. However, the saving in moving time would not be justified, or gained, unless the efficiency during the drilling operation was at least equal or superior to the conventional rig.

Details are given of the engines and transmission and of the pumps and other items in the rig. The rig was completely assembled for the first time on the location. Only minor adjustments were necessary, and these were readily made. Fitting of pump suctions and other such details were necessary on the first job, but will not have to be repeated. So far the rig has never been moved, except to drive it from the factory, and there is no test as to just how long it will require to rig up. As the crew becomes more familiar with the job, the moving and rigging-up time will be reduced to a minimum.

The rig has been drilling for several weeks and has come up to expectations. Drilling time and time for making trips are comparable to rigs of standard design operating in the area, and it is evident that when the crews get used to the operations, a decrease in well time will be effected. A. H. N.

238.* Improved Rebuilding Methods Extending Tool-Joint Life. E. Sterrett. *Oil Wkly*, 22.12.41, **104** (3), 16.—In an extensive paper, all phases of rebuilding tool-joints are discussed. A joint in a 4½-in. drill-string under certain drilling conditions is considered as having suffered maximum safe reduction in cross-sectional area if the diameter of the outer surface has been reduced by ⅛ in., or if the wear, assuming uniform attrition, is 0·1875 in. Below this margin the joint is a potential location of failure through splitting or swelling when torque exceeds the normal safe amount for the type of string being run.

The amount to be built up, being only $\frac{3}{16}$ in. in thickness, lies well within the practicable working limits of a single bead with ¼-in. welding rod. Usual practice is to apply circumferential beads at both ends of the tool-joint as a rolling weld, using a copper chill-ring if the elevator shoulder is cut away enough to require more building up than can be obtained by a single bead. With the two ends thus brought out to size or slightly in excess of the original nominal diameter of the joint, longitudinal beads are laid up from end to end of the joint until an entirely new surface is completed. To prevent spatter or damage to the pin-threads they are covered by a thread protector before beginning the welding. Possible distortion of the threads is also minimized by using copper chill-rings at both ends of the job during welding.

The ridges left on the tool-joint by the parallel series of beads are not detrimental to tool-joint wear, the abrasion in service tending to grind the surface again to a true cylinder. Tonging, especially the first few runs of the pipe, is appreciably slowed down, it being necessary to engage the tongs carefully to prevent slippage and consequent breakage if the die engage on top of one of the bead-ridges.

When hard-facing material is used in conjunction with the usual high-carbon rods used for such a rebuilding job, it is customary to build up the ends with the hard facing, extending the width of the band covered by the circumferential bands from

the width of at most two beads to as much as 1 in. "Half-soling" the tool-joint is also resorted to. This method is discussed.

Any tool-joint, before reconditioning, should be checked for eccentricity, and discarded as unsuitable if found to be more than 0·05 in. out of round from use on crooked pipe. This eccentricity may best be determined by spinning the joint in a lathe or between centres, in which the actual joint support is obtained through the jaws gripping the threads, or special threaded fittings into which the pin, box, or double ends fit accurately. Bearing face width variation is also a true indication of this condition. Eccentricity troubles are discussed at length. Hard facing methods and requirements are detailed. Elevator shoulder and wear subs are similarly discussed *in extenso*. The paper ends with a report on flame-hardened wear subs. The flame-hardened subs, checked at the 28,000-ft. mark, were found to have sustained an average wear at point of maximum attrition of 0·049 in., and at 65,000 ft. showed a reduction in diameter at the upper end checking point of only 0·08 in. Over the entire run up to the time of the second check, it was determined that the feet of hole drilled for each 0·01 in. of maximum wear was, for the old joints (untreated) 2400, for the hard-faced 3600, and for the flame-hardened 6100 ft. These figures, of course, are not over the hard-faced band, which, after all this running, still showed within 0·08 of its initial diameter. Wear of the band below the hard-faced band indicates that the protection is most effective at the shoulder, and the band at that point is in position to give maximum shielding effect. A. H. N.

239.* Design of Casing Strings. Part 4. E. N. Kemler. *Oil Wkly*, 22.12.41, **104** (3), 36.—Factor of safety is that term used to cover the discrepancy between actual practice and theory. The size of the factor of safety to be used will be determined by what it must cover. Some of the things it must take into account are discrepancies between test data and actual performance, inability to determine actual loads to which casing is subjected, and ignorance of designer as to properties of product, application conditions, or theory.

As far as collapse is concerned, the prediction of loads can be made with very good accuracy. The pressure which normally causes failure is the result of a hydrostatic pressure of a column of mud, and is not normally subjected to any dynamic loading. Under normal conditions the collapsing pressure can be very closely predicted. For normal conditions, no additional allowance need be made for calculated loadings if all factors are known.

The evaluation of the strength of the product is a more difficult problem. Two methods of approach are possible in this connection. One, which has been widely used in the past, has been to base the strength on average properties or strength values. The other, which has been introduced recently, is to base all values on minimum values. The use of 75% of the average value as the minimum value for casing collapsing pressures shows why relatively high factors of safety have been necessary in the past. For example, a factor of safety of 2 based on average values would be equivalent to a factor of safety of 1·5 based on the minimum values. The designer has had to introduce a factor of 1·33 in order to reduce average values to minimum values.

The arbitrary setting of a minimum value is not guaranteed to meet the situation. In order to be able to evaluate the meaning of the minimum value, the designer must know something about the control exercised by the manufacturer. The theory of statistics forms one method of evaluating the strength of commercial casing.

The rest of the paper illustrates the principles by working out an illustrative example in detail. A. H. N.

240.* Design of Casing Strings. Part 5. E. N. Kemler. *Oil Wkly*, 20.12.41, **104** (4), 34.—A decrease in temperature of the casing string or an increase in internal pressure would result in an increase in tension in the string after the cement has set. In some cases tension failures both of pull-out and fatigue type have occurred. It has been contended by some that a release of tension after the cement has set would eliminate these failures. Since it is physically impossible to measure stresses and observe load changes down the string, it is difficult to determine the actual cause of such failures. This article gives charts and methods by which the amount of load and tension to release for a given set of conditions can be calculated.

If the combination initial and these secondary stresses exceed the pull-out strength, the string will fail. If the above combination of stresses does not exceed that required to cause pull-out, failure can occur due to fatigue, provided a variation in stress occurs. This variation in stress can occur because of whipping of the drill-pipe. The magnitude of these stresses is indeterminate. The fact that some failures occur by fatigue indicates that the drilling operation introduces in some form variations in stress of sufficient magnitude to cause failure. Failure by fatigue requires a variation in stress. Failure can result from a high direct stress with little variation or a low direct stress with a large variation. If the direct load or tension is kept to a minimum, the danger of failure because of fatigue will obviously be kept to a minimum. The direct load can be controlled by release of tension after the cement has set.

If, however, too much tension is released, there is danger of failure by buckling, and perhaps some danger from fatigue in the region of zero or compression stress, since a little force perpendicular to the pipe could cause a considerable sideway deflection and bending stress. If the pipe were free of the hole for its entire length there would be little danger in tension release as far as danger of introducing a compression section is concerned. Since, however, caving or settling of formation can occur in many of the formations encountered very shortly after the casing is cemented, it is difficult to know how much tension to release.

The length of free casing can be determined by releasing part of the load and measuring the corresponding change in length of the string. Formulæ to be used are given.

A. H. N.

241.* **Statistical Data on Drilling in 1941 and Estimates for 1942.** Various Authors. *Oil Wkly*, 26.1.42, **104** (8), 50.—This issue of the *Oil Weekly* is devoted to statistical data and forecasts on drilling in the U.S.A. for 1941 and 1942, respectively.

A. H. N.

242.* **Determination of Slot Sizes for Liners in Argentine Oil-Fields.** D. F. R. Ruiz. *Petrol. Engr*, November 1941, **13** (2), 23–28.—Experience in the fields of Argentina has shown the necessity of maintaining the walls of the drilled well intact, so as to avoid changes in its productivity during production. This is accomplished ordinarily by inserting pipe in the bottom of the well, with openings of various designs, which permit passage of the oil, but impede the permanent flowing of the grains of sand carried with the oil. This procedure is in general use, and is indispensable when the casing show of the well has been cemented above the productive zone. Other systems are employed that obtain the same results, although it may be because the sandstones are sufficiently consolidated to make the setting of perforated pipe unnecessary. In some cases the casing is run and cemented all the way to bottom, and is then perforated through the oil-zone; in others the lower part of the string is made up of casing previously perforated.

A discussion of slot design is given particularly applicable to the fields studied. It was found by Coberly that uniform grains of sand were retained almost entirely by slots of double the diameter of the grains. If the width of the slot was made equal to three times the diameter of the grains, all the sand passed through the slot. With the width of the slots understood to be between these two limits, a certain amount of sand passes before the forming of the bridge, the amount being greater as the size of the slot approaches the maximum limit. With the objective of establishing whether the angular form of the grains of sand had some influence on these results, a test was made with steel balls. These behaved in like manner, the sole difference being that the extreme limits of the slot were found to be between 2 and 2½ times the diameter of the steel balls.

It was found at the same time that in sands composed of grains of different sizes a small percentage of coarse grains modifies the action greatly and considerably increases the width of the slot on which the bridge is formed. Coberly introduces a new concept that may be called the "effective diameter of the grain," which states that the correct width of the slot is determined by multiplying the "grain" diameter by two. Experiments show that the effective diameter of the grain is not represented by the largest grains that are present in the sample, but by the grain that corresponds to a certain point on a curve of accumulated percentage compiled from a screen analysis. This percentage varies from 5 to 20 on the curve, and the form it assumes

influences the establishment of the critical point at which the bridge is formed after a few grains may have passed through the slot.

Curves of uniform gradient, or those that show a regular distribution in the individual percentage of the sizes, will have critical points nearer to 5%. An irregular curve, on the contrary, will place the critical point nearer to 20%; but in all cases the critical point will be found between these two figures.

A standard procedure is described for choosing slot designs and dimensions in the light of these and certain other experimental results. Completion practices are described. A. H. N.

243.* New Drilling Time Recorder Provides Effective Well-Log. W. A. Sawdon. *Petrol. Engr*, November 1941, **13** (2), 29.—The instrument, which is semi-automatic, consists essentially of a visual depth-chart across which a pen or stylus moves at a constant speed until re-set to its zero position by pressing a trigger. Each time the trigger is pressed the stylus carrier is lifted from the constant-speed drive and is instantly returned to the left margin by a spring. Pressing the trigger also advances the chart a fixed distance, so that the time lines of various length are evenly spaced.

The chart itself is 6 in. wide, and feeds upwards through the recorder from a roll in the lower part of the instrument. Perforations in the edges of the paper provide a means of moving the chart vertically, leaving 5 in. of width for the drilling-time record. The drilling-time curve is recorded in a 3-in. strip on the left, which is ruled vertically with six timing lines, each line representing 5 min. of stylus travel. The 2-in. column to the right of the drilling-time record is available for writing in depths, dates, and any notes that may be desired on the record.

The stylus is carried across the chart at constant speed by a chain driven by a clock mechanism. The clock has a conventional escapement movement, but winding is automatic; on pressing the trigger, which causes the stylus to return to the left margin, all energy taken to make the stylus travel to the right is put back into the clock-spring. When the stylus travels the full distance across the chart, the clock automatically stops.

For direct correlation with electrical logs, the chart is designed to move 2 in. for each 100 ft. of hole drilled, or $\frac{1}{50}$ in. per ft. The usual constant-depth interval is 1 ft., and the ratchet advances the chart $\frac{1}{50}$ in. each time the trigger is pressed.

When the interval for timing is 1 ft., the driller has the kelly marked or "striped" at 1 ft. intervals. The chart is then set so that the depth of the hole is correctly indicated on the depth-scale of the chart and the recorder is set in motion simultaneously with the beginning of the drilling. The stylus begins making a drilling-time line at the proper depth on the chart, and runs continuously across the chart at the rate of 1 in. each 10 min. When the first 1 ft. mark on the kelly comes down to the rotary table, indicating that the first 1 ft. interval has been drilled, the driller presses the trigger. This re-sets the stylus at zero time and moves the chart the equivalent of 1 ft. in depth. The stylus now starts across the chart again, drawing a line the length of which will be a measure of the time taken to drill the second 1 ft. interval.

A. H. N.

244.* Improved Method for Changing Blow-Out Preventer Rams. R. M. Lilly. *Petrol. Engr*, November 1941, **13** (2), 108.—To facilitate the changing of Cameron type S.D.A. blow-out preventer rams, the engineers of a major oil company have designed and developed an improved hydraulic method that permits this changing operation to be accomplished with a speed, ease, and convenience of manipulation hitherto unapproached.

Apart from the elimination of the manual effort involved in changing rams by the use of hand-operated mechanical jacks and clamps, the points of superiority of the improved hydraulic over previously used methods are as follows: (1) lower initial cost of equipment; (2) it is much faster and safer; (3) equipment is unitized and portable, being very small, compact, and light. The material used consists of three $1\frac{1}{2}$-in. by 1-in. short-swage nipples, a short piece of high-pressure wire-wrapped steam hose with special short steel couplings, a 4-way valve of suitable type and pressure rating, three 2-in. by 6-in. wooden blocks of varying lengths to press the dressed ram out, and a steel chain and socket arrangement to pull the replacement ram in. All this equipment is of the heaviest possible character, in order to withstand drilling-

rig abuse. Four 1-in. hammer-lug unions are positioned in such a manner that the parts may be quickly assembled and dis-assembled.

The equipment is housed in a small metal tool-box, fitted to accommodate the various parts. The internal construction of this box is such that there is a specific place for each piece of equipment, and, when the lid is closed, each part is securely locked in place, and cannot be damaged by striking other objects contained therein.

To change the rams, the valve in the opening manifold is closed. The bolts are removed from one cylinder, and the control valve is connected thereto. The valve is manipulated so as to permit fluid to enter this dismantled cylinder, shoving cylinder and head off as a single unit. The valve is now unioned to the active side. Wooden spacer blocks of various lengths are placed between the rams, and the control valve manipulated as necessary to shove the dismantled ram from the bore. While this ram is being stripped, the replacement ram is picked up, aligned, and drawn into the preventer bore by the simplified draw-chain and socket arrangement. It is then dressed, and the cylinder and head are picked up, aligned, and drawn to position in the same manner.

The control valve is now moved to the re-assembled side, and the operation enters the second phase, the routine of which is exactly as described above.

Results of tests are given in detail which show that the time taken with this method is shorter than with mechanical methods. A. H. N.

245.* Medium Weight-Drilling Equipment Employed in Deeper North Texas Drilling. H. L. Flood. *Petrol. Engr*, December 1941, **13** (3), 29–32.—The rig, designated as a 7500-ft. assembly, is relatively new, and incorporates several features in its design that are extremely interesting. Despite the size and weight of equipment required for 7500-ft. drilling, the rig is easily and quickly moved. The draw-works, two of the 325-h.p. engines, and the transmission are mounted on an 8-ft. substructure. Both 15-in. mud-pumps are mounted at ground level, one being driven by V-belts from a sheave on the shaft of one of the two drilling engines. The other pump, serving as a stand-by unit, is powered separately by a third 325-h.p. engine.

The draw-works has a selection of six hoisting speeds and three rotary drive speeds. The heavy-duty transmission unit has three forward speeds and one reverse speed, and includes a counter-shaft and a jack-shaft. All power to and within the draw-works is transmitted by means of sprockets and chains, and all shafts are mounted on self-aligning roller bearings. Double chain having a 2-in. pitch is used for all drives except the engine and combination rotary and high-speed drum drives, which are 1½-in. pitch triple and 3½-in. pitch single chain, respectively. The cat-shaft is powered by 2-in. pitch single chain from the jack-shaft.

The use of hydraulic couplings on the two main engine drives is perhaps the most unusual feature of the entire assembly. The coupling is mounted on the engine shaft between the clutch and the belt-sheave. Completely enclosed by screen wire-guards, the couplings require very little additional floor space, and virtually no attention is required by the operator, except for occasional routine inspections.

The hydraulic drive endeavours to combine the torque-speed characteristics of the electric transmission with the high flexibility, high efficiency, low weight, and simple controls of the gear-box transmission. The advantages obtained with a hydraulic drive are as follows: (*a*) smooth starting; (*b*) absorption of shock loads; (*c*) absorption of engine torsional vibration; (*d*) limiting torque capacity; (*e*) high torque capacity at low r.p.m.

The mud system and other equipment are described. A. H. N.

246.* Drilling Practices. C. W. DeLancey. *Petrol. Engr*, December 1941, **13** (3), 98. *Paper Presented before American Association of Oil-well Drilling Contractors.*—The requirements put by operators to contractors are discussed. First of these is blow-out prevention. To be certain that failures do not occur, it is a good policy to require each crew to operate the preventer equipment once during their respective tours. Top control equipment will not be effective unless the casing to which it is attached is in good condition. Crooked kellys and eccentric motion of the rotaries are the chief causes of excessive wear near the surface. It is safe to assume that a motion similar to that of the swivel and tackle will occur under the rotary. In fact, it may be amplified in a manner similar to that of a rope artist, wherein a slight motion

of the wrist is increasingly amplified in the rope. A study of wear was made in casing recovered from abandoned wells, and it was found that the point of greatest wear was not in the top joint, but between 100 and 200 ft. below the surface.

On wells where conductor pipe is not used, and where it is not possible or advisable to cement the surface casing to the top, many operators have found it advisable to cement the top 100 ft., in order to prevent sag and vibration. This can be done with small expense while the cementing equipment is on location.

Stuck-pipes are also discussed. Inasmuch as pipe usually sticks near the drill-collar assembly, it has become a general practice to install a safety joint at or near that point. Of necessity, the joint is designed with loosely fitting threads, and because of this fact some failures have occurred. It is probably advisable to run the safety joint one joint above the drill-collar to procure flexibility between it and the stiff-collar assembly, and at the same time retain the advantage of having the minimum amount of assembly to recover by wash-over or other means.

The driller should always bear in mind that the function of a safety joint is to provide a means of quickly freeing a large part of the drill-pipe, and to prevent further sticking until necessary tools have been obtained and a satisfactory plan has been adopted.

Other problems discussed are bridging of soft formations, key-seating, drill-pipe connections, cementing, and mud treatment. A. H. N.

247.* Trends in Rotary Drilling Machinery and Equipment. J. M. Shimer. *Petrol. Engr*, December 1941, **13** (3), 129. *Paper Presented before American Association of Oil-well Drilling Contractors.*—The past and present practices are briefly reviewed and recent innovations are mentioned. Probably the most outstanding improvement in rotary rigs in the last few years is the independent drive to the rotary table, in which a separate prime mover is used instead of the hoisting engine. This type of drive was first used on steam-rigs where there are two types, one being the unit type in which rotary table, gear-box, and twin vertical engine with flexible coupling connections are mounted on a skid-frame and placed on the derrick floor in a position where there will be the least interference when bringing in, racking, and laying down the drill-pipe. Another type of independent table drive on steam rigs consists of placing the twin steam engine below the derrick floor in the cellar, when sufficient space is available, and driving from the engine to the rotary pinion-shaft by chain. In both types the steam engine has a remote throttle control and reverse located at the driller's position.

Rotary table speeds of 500 r.p.m. and higher are uncommon in the Mid-Continent area, but are used quite generally in the deep wells in California. This type of service is very severe, especially when taking into consideration the fact that the horse-power requirements are usually calculated to be 1 h.p./revolution/minute, or 500 h.p. at 500 r.p.m. This figure obviously represents high torque combined with high bearing speeds, and calls for rugged, precision-built rotary tables adequately lubricated, perfectly balanced, and made of the very best materials. The modern rotary table represents probably the greatest advance in drilling machinery design. Having anti-friction bearings throughout, spiral bevel, accurately cut, surface-hardened gearing, and complete oil-bath lubrication, it performs the most difficult job on the rig with a minimum of maintenance cost. It is not inconceivable that before long, table speeds of 1000 r.p.m. may become quite common.

Prime movers, swivels, and hoists are discussed. A. H. N.

248.* Advances in 1941 Drilling Equipment Demonstrated in California. N. A. D'Arcy, Jr. *World Petrol.*, January 1942, **13** (1), 44–49.—Light drilling equipment made great strides, and many refinements were introduced in heavy drilling equipment. Internal-combustion engine-power units were practically unanimously chosen by operators in all fields, with California operators showing a decided preference for independently powered slush-pumps. Increased attention was given to mud-pumps and mud conditioning, as much of the drilling was in difficult localities. Three principal types of portable derricks or masts proved their worth in California within the past year. These are the jack-knife, the telescoping, and truck-mounted units.

A large three-cylinder steam pump made its appearance in 1941. This pump, having an 18-in. diameter steam cylinder, 20-in. stroke, and liners up to 7¼ in. in diameter, provides maximum fluid from but a single pump. The pump is designed for 3000 lb. working pressure, and was actually working against a 2700-lb. manifold pressure on much of the first hole on which it was used. It is reported that the three cylinders so smooth the pumping action that the pump has the appearance of idling even when operating against high pressures at comparatively fast speeds. Mud treatment and cooling are discussed.

Developments in draw-works are reviewed, including the type designed to guide wire rope satisfactorily over the third layer.

The water-tube boiler-power plant in California was in operation 240 days drilling one test-well, approximately 12,900 ft. deep. During this period the boilers did not cause a single shut-down, nor was there a single boiler-maker or boiler-maker's helper on the job. A complete elimination of stay-bolts, seams, flue sheets, corrosion, and scale was responsible for this trouble-free service. The boilers operated on evaporated water, thus eliminating the deposit of scale in the tubes. The evaporator itself was not opened for cleaning during the entire 240 days. It was cleaned by temperature changes and the flushing out of the released scale. Boilers are not yet operating with their recommended size burner, yet they have yielded 300% of their rated capacity of steam with 60% efficiency and a stack temperature of only 620°. The elimination of seams and stay-bolts greatly reduces a common boiler hazard, and the safety angle of Type S.A. water tube oil-field drilling boilers should be considered together with economies in operation. A. H. N.

249. Patents on Drilling. D. E. Batchelder. U.S.P. 2,265,978, 16.12.41. Appl. 4.10.39. Alternating-current electrologging of well-bores.

R. F. Bolton. U.S.P. 2,265,982, 16.12.41. Appl. 6.11.39. Directional drill-bit having an inclined lower portion of the body.

R. G. Piety. U.S.P. 2,266,071, 16.12.41. Appl. 31.5.39. Well-surveying device for electrically logging wells.

A. C. H. Cooke. U.S.P. 2,266,357, 16.12.41. Appl. 21.11.39. Releasable cable-head for multi-strand cables.

W. K. Edwards. U.S.P. 2,266,361, 16.12.41. Appl. 9.5.40. Weight unit indicating apparatus using deflection of cable.

H. J. Quintrell and B. F. Irwin. U.S.P. 2,266,382, 16.12.41. Appl. 11.12.39. Setting tool for bridging plugs.

H. J. Quintrell. U.S.P. 2,266,383, 16.12.41. Appl. 2.1.40. Well-bore deflecting tool with a knuckle joint.

S. W. Gurasich. U.S.P. 2,266,623, 16.12.41. Appl. 14.9.38. Method of surveying bore-holes and locating tools therein.

A. T. Cooper. U.S.P. 2,266,739, 23.12.41. Appl. 13.1.40. Well fishing-tool with a member having a central opening.

C. E. Lang. U.S.P. 2,266,873, 23.12.41. Appl. 21.11.38. Overshot.

M. W. Lukes and S. G. Davies. U.S.P. 2,266,883, 23.12.41. Appl. 14.10.38. Rope socket.

J. A. Pitsch. U.S.P. 2,267,252, 23.12.41. Appl. 19.11.40. Hose coupling.

N. Johnston. U.S.P. 2,267,683, 23.12.41. Appl. 10.1.39. Use of fusible metals in drilling wells.

C. R. Athy. U.S.P. 2,267,705, 30.12.41. Appl. 27.1.41. Oil-field apparatus comprising a unitary derrick made of separately united sections.

A. Boynton. U.S.P. 2,267,716, 30.12.41. Appl. 23.6.39. Threadless drill-pipe.

T. E. McMahan. U.S.P. 2,267,833, 30.12.41. Appl. 9.2.40. Well-bit guide having roller cutters.

A. E. Johnson. U.S.P. 2,267,923, 30.12.41. Appl. 16.9.40. Shear-reducing dual verge thread for tool-joints, etc.

V. E. Baum. U.S.P. 2,268,010, 30.12.41. Appl. 15.4.39. Method of and means for cementing well formations.

H. M. Evjen. U.S.P. 2,268,137, 30.12.41. Appl. 11.12.39. Electrical well-logging system.

H. M. Evjen. U.S.P. 2,268,138, 30.12.41. Appl. 11.12.39. Electrical well-logging system.

A. C. Lusher and A. J. Scholtes. U.S.P. 2,268,142, 30.12.41. Appl. 27.9.39. Coupling with collapsible nipple flange for hoses.

W. S. Knouse. U.S.P. 2,268,256, 30.12.41. Appl. 3.2.40. Apparatus for surveying deep wells.

E. S. Davis and J. H. Reynolds. U.S.P. 2,268,385, 30.12.41. Appl. 20.12.39. Hose coupling.

G. T. Oberwetter. U.S.P. 2,268,514, 30.12.41. Appl. 15.7.40. Side-wall core-taking apparatus.

D. Silverman. U.S.P. 2,268,627, 6.1.42. Appl. 6.10.39. Well-logging by means of two liquids.

E. R. Webb. U.S.P. 2,268,682, 6.1.42. Appl. 9.10.37. Well-surveying instrument using a pendulum.

M. J. Potvin. U.S.P. 2,268,775, 6.1.42. Appl. 29.5.40. Drill-bit with a single plane cutting face.

W. Brauer. U.S.P. 2,268,796, 6.1.42. Appl. 5.8.39. Sectional derrick for oil-field work.

F. W. Jessen. U.S.P. 2,269,269, 6.1.42. Appl. 15.7.40. Well-logging for locating the discontinuities of a metal conduit, using an electrolytic solution.

D. Hering. U.S.P. 2,269,717, 13.1.42. Appl. 13.12.40. Well-surveying device, using a marking liquid and siphons in a multiple chamber unit. A. H. N.

Production

250.* Trends in Production Practices. Anon. *Oil Gas J.*, 25.12.41, **40** (33), 202.—A review of the new developments and practices evolved in 1941 for the production of oil and gas is given. The past year saw development of a new liner cleaner. The washing fluid is pumped down from the surface, emerging from the washing tool at a point between two opposed swab rubbers about 1 ft. apart, so that the entire flow of fluid can be forced through a selected interval of the liner. A recording pressure gauge at the surface shows how much pressure is required to force fluid through any given set of perforations, thereby showing when the liner has been sufficiently cleaned, and also providing a check on the setting of the liner's perforated sections. The method is applicable to perforated, slotted, or pre-packed gravel liners. Other cleaning practices, including the use of explosives, are given.

Present emphasis in the gravel packing of liners is on proper placement of the gravel. It has been recognized that careful selection of gravel of the proper size will be of no avail if the placement job does not result in a tightly packed envelope of gravel completely surrounding the perforated pipe. Failure to cover the liner properly in just one place may prevent the remainder of the gravel pack from accomplishing its purpose. A study of wells in the Wilmington, California, field has revealed that the gravel-packed and pre-packed liner wells show greater product ionrates than do the conventionally completed wells. This, however, does not clearly establish their greater productivity, because the wells are prorated, and are not ordinarily allowed to produce at maximum capacity, even on potential tests. The data merely indicate either that the gravel-lined wells can be produced at rates more nearly approaching their capacity without detrimental effect, or that when restricted by a given-size choke, they will produce more oil than their neighbours.

The side-inlet choke is being used very successfully for controlling the gas–oil ratios

in flowing wells where the gas is mainly derived from a sand above the oil-pay. In wells of this type the gas sand is cemented off behind the casing or the liner during completion, but is opened up by several holes shot through the pipe by a gun perforator. When the tubing is run, a packer is installed with a side-inlet choke above it. The packer is set in the blank portion of the pipe, just below the gun perforations. Gas entering the hole is then available above the packer, whilst the oil enters the tubing below the packer. The side-inlet choke then provides a means of admitting gas from the casing into the tubing at any desired rate.

Production restoration and the maintenance of good efficiency in lifting oil are discussed.

The paper ends with a discussion of lease-tank batteries. Even on the most simple of vapour-tight batteries it is possible to avoid admitting oxygen during drainage of the tank by merely installing a small line to the top of the tank from some source of supply where gas will be available while the tank is on the line. The gas may be supplied from a separator which discharges into a different tank, or from a residue line, or from a well.

Other rules for tank care include immediate repair of seam leaks, frequent inspection of bottoms to guard against the start of corrosion, and regular application of paint. Proper drainage at the base is important, as water within the fire-walls tends to increase corrosion from the outside. For maximum life the tank should be mounted on a raised foundation of concrete, or a steel platform. If such a foundation is not used, the setting should be prepared by placing a level bed of gravel on solid ground and covering it with tar paper or other waterproof material.

The paper is given in both English and Spanish. A. H. N.

251.* La Gloria Condensate Recovery Plant Unusual Joint Enterprise. N. Williams. *Oil Gas J.*, 1.1.42, **40** (34), 30.—This paper comprises a section of the present issue of the *Journal* devoted to the operations in La Gloria. Operations providing for the maintenance of reservoir pressures and recovery and distillation of condensate from high-pressure gas-producing horizons are under way in La Gloria field, located in Jim Wells and Brooks Counties, South Texas. In volume of gas to be processed, this project is the largest of its kind yet undertaken. It is also an outstanding example of a large-scale conservation programme initiated in the very early development and productive stages of a field.

Installation of a processing plant for the extraction of condensate from the wet gas produced and for the return of the dry residue gas to the producing sands has been the essential phase of the project. Highly diversified lease and royalty ownership within the prospective limits of the productive reservoirs has made the pooling of interests and unitization of the field a major factor and pre-requisite.

The plant, owned and operated by La Gloria Corporation under a life-of-property contract with leaseholders in the field, has facilities for handling more than 225,000,000 cu. ft. of gas daily. Operations cover two adjoining, unitized blocks totalling approximately 6475 acres. Embraced in the unitization is a subdivision of lands adjoining the townsite of La Gloria, composed largely of tracts of 40 acres or smaller.

Participating in the blocks are ten separate leaseholders and sundry royalty interests.

Early development is reviewed. Producing wells are being spaced at approximately equal distances on the periphery of a circle around the rim of the blocks, constituting roughly the outline of the condensate-producing area of the structure. The plant is located near the centre of the circle. Like the input wells, each of the producing wells is a double completion to produce from two of the four sands. This makes La Gloria the first field in which all wells are dual completions.

The gathering system will ultimately contain more than 9800 ft. of 8-in. main line with approximately 23,000 ft. of 6-in. secondary lines, and more than 32,000 ft. of 4-in. secondary and feeder lines. The main line extends northward and southward across the field from a juncture just west of the plant with the plant intake line. Connecting at different points on this main line are the 6-in. secondary or lateral lines serving various sections of the field. The latter are fed by the 4-in. feeder lines from the individual wells.

Composition of the gases in this field is discussed, together with characteristics of the gathering and separation plants. The absorption system as used is detailed. The paper ends with a list of the equipment used. A. H. N.

252.* Cost Study of Fort Collins-Wellington Field, Colorado. F. N. Bosco. *Oil Gas J.*, 15.1.42, **40** (36), 50.—The cost of producing oil in Colorado has already been shown to exceed the net value of the reserves plus oil produced. The following are also shown: A cost of 25 cents/brl. in excess of the field value of the crude and reserves when produced. The proven-oil reserves plus production for the 70 years preceding 1932 (the last year in which complete cost data were available) equalled 54,154,000 brl. The oil had a field value of $43,721,753, although the total cost of producing this amount of oil is $56,837,000. The net loss of -$13,115,247 has been paid by wildcatters and others who may or may not have benefited by the sale of the oil. Certainly any fair determination of the cost of finding and producing oil should include the cost of wildcatting.

A study is presented of one of the best fields in Colorado—the Fort Collins-Wellington field, which is 6 miles north of Fort Collins, in North-Eastern Colorado. Production is from an approximate depth of 4300 ft., and the producing horizons are the Muddy and Dakota sands in the Dakota formation. The structure is a closed anticline, with two separate highs. The pool was opened on 11th November, 1923, the first well yielding only gas. The entire field will be discussed in an article on Eastern Colorado which will appear in an early issue of the *Oil and Gas Journal*.

It has been found that, for the 20-year period following discovery, using reasonable cost data as presented in this article, the net loss to the producers would have been approximately $1,400,000 while producing 5,275,000 brl. For the study it was assumed that market value was $1 a barrel; actually some of the oil sold for $2.50 a barrel, so that the field may have shown a profit.

Drilling, as well as production costs, are given in some detail and are tabulated.

A. H. N.

253.* Back-Wash by Gas-Lift Increases Efficiency of Salt-Water Injection. G. B. Nicholson. *Oil Wkly*, 29.12.41, **104** (4), 19–21.—To clean the formation face of salt-water injection wells, one company in a field in coastal Louisiana installed a tubing string equipped with flow-collars to permit back-washing by gas-lift. Favoured by presence of a shallow salt-water-bearing sand which receives the injection water under a vacuum, the company periodically augments infiltration by applying pressure from a nearby gas-well into the tubing, flushing water through the casing to the salt-water pit, and carrying accumulated sand and residue from the formation face. Washing action expurgates the receiving formation, opening pores and removing materials which deter movement of input water into the sand.

The history and peculiarities of the field are briefly given. Salt-water treatment is described in some detail. The most troublesome element to remove from the water is iron oxide, which, reduced from a ferrous to a ferric state by aeration, is insoluble, but reluctant to precipitate. Experiments show that this substance, when a solution is allowed to pass through a sand-core, is caught on the face of the sand, and clear water filters through. Such experiments also show that iron oxides do not penetrate into the sand, but stick chiefly on its face, to account for plugging the formation pores in input wells. This has been determined in actual wells by washing, with water removing the deposited oxides from the formation and reopening the sand for injection. As a result of these experiments all salt water is filtered before injection, to remove all solid particles.

After a period of operation, a gradual decline in vacuum at the well-head indicates that the formation is no longer taking the water as freely as under normal conditions, usually attributable to a partial sealing of the face by deposition of the solids, including iron oxides formed by the corrosive water passing through the steel pipe, the natural tendency to react aggravated by aeration. Continued injection would further reduce the vacuum and necessitate additional pump pressure to increase the hydrostatic pressure applied against the formation.

To prevent complete clogging of the sand-face, water injection is temporarily suspended while the formation is cleaned by back-washing. Already permanently connected with the gas-well, gas is readily admitted to the tubing, circulating the water from the casing back into the pit, and washing the filters by the reverse circulation. In this manner the sealing solids and accumulated sands are quickly washed from the well, opening pores to facilitate further injection. In the meantime water from the gun-barrels continues to empty into the reservoir.

A. H. N.

254.* Complete Flow-Tank Vapour-Recovery System. Anon. *Oil Wkly*, 29.12.41, **104** (4), 22–23.—The paper describes, with illustrations, a system of vapour lines on tanks to provide freedom of passage of vapours from one tank to another, to compensate for the variation in pressure while one or more are being filled and others being emptied. This is accomplished without infiltration of air into the battery or loss of vapours. The system is separate from the traps on the wells, but the vapour recovered from the tanks is fed into a gathering system, which conveys the gas to a gasoline plant.

Town-lot locations and complicated royalty interests make it necessary to equip many individual wells with separators, but as measurement of both oil and gas is accomplished with approved meters, grouping of separators and flow-tanks at convenient centralized points permits this type of vapour-saving equipment to be used. Each well and its separator are furnished with at least two flow-tanks. The vapour system is connected to all the tanks in the battery, and contains equipment and control instruments to maintain a predetermined pressure on all tanks alike.

The methods of construction and other details are briefly given. A. H. N.

255.* Modification of Permeability Measurements. H. Krutter and R. J. Day. *Oil Wkly*, 29.12.41, **104** (4), 24.—The paper directs attention to Klinkenburg's paper on permeability of rocks to air, and explains the calculations used. Klinkenburg showed that permeabilities, as ordinarily measured, using air, varied, depending on the mean pressure used in the measurements. The higher the mean pressure used, the lower the calculated value of the permeability. This variation is most striking for low-permeability cores, and decreases with increasing permeability. At very high mean pressures (essentially infinite mean pressure) and low differential pressures, so that there is no question of turbulence, the value of the permeability, as determined using air, agrees with that obtained using various liquids. In this work care was taken that the question of swelling did not take place. The large differences obtained between the liquid permeability and the air permeability as ordinarily determined indicate that the swelling of clays does not play so important a rôle as was once thought.

Klinkenburg's results are briefly summarized by the equation $K_a = K\left(1 + \frac{b}{Pm}\right)$, where K_a is the permeability obtained with air at a mean pressure, Pm. The constant b depends on the pore pattern of the core, and decreases with increasing permeability. K will be the new defined permeability, and will also be the permeability which should be obtained if liquids were used as flooding mediums. The quantity which is a characteristic of the core is therefore K, and not K_a.

A graph correlates the constant b with the permeability of various samples for Venango second sand. The relation is given as a straight line.

A nomograph is given to facilitate calculations. A. H. N.

256.* Widely Spaced and Varying Depth Wells Pumped Efficiently by Large Centralized Hydraulic Plant. G. M. Wilson. *Oil Wkly*, 5.1.42, **104** (5), 17.—Ten widely spaced wells are pumped from a central plant housing six triplex units. The ten wells operated by this central power plant had been on gas-lift and ordinary rod-pumps until two years ago, when it was decided to equip them with hydraulic pumps. The pumps in four of the wells are set at 4500 ft., four at 6000 ft., and two at 6500 ft. They are located in the fairly precipitous terrain characteristic of this portion of the field. The well most remote from the plant is more than 2500 ft.

All the units are connected to a single outside cooling tower, making it possible to close the building tightly during heavy rain-storms or other bad weather. The 25-ft. high, 12 × 12 × 20 cooling tower has ample cooling capacity for the units. At the base of the tower are four 2-in., 60 gal./minute-capacity electric circulating pumps. Two of them circulate all the water through the units, one is a stand-by, and the other circulates water through the tower itself. A water-softening unit is used in connection with the tower, which helps to reduce scale troubles to a minimum.

Before entering the intake line serving the triplex units, the heated power oil, coming from the dehydrator plant, is run through a trap. Here any vapour is removed from the oil, so that only dead oil enters the pumps. The fluid-level is automatically maintained at a certain line in this trap. A pressure of 15 lb.—just enough to charge the pumps—is held on the intake line.

The 2-in. trunk-line coming out of the plant extends uphill, and approximately bisects the area taken in by the wells. The single pump pressure of 3000 lb. is held on this line. From this main line laterals take off to serve the various wells. Not more than two wells are served on each lateral. When a single lateral takes off to one well, 1-in. pipe is used; when two wells are served from one lateral, 1¼-in. pipe goes to one well, the second well being operated through a 1-in. pipe extension. The pipe is high-pressure seamless, galvanized inside and out. All lines are buried. The power oil leaves the plant at 140° F., in order to keep the paraffin in solution through all the power-oil and lead lines. Other data, together with advantages of the plant, which has been running for two years, are given. A. H. N.

257.* Statistical Data on Production in 1941 and Estimates for 1942. Various Authors. *Oil Wkly*, 26.1.42, **104** (8), 40.—This issue of the *Oil Weekly* is devoted to statistical data and forecasts on production in the U.S.A. for 1941 and 1942, respectively. A. H. N.

258.* Critical Analysis of the Application of the Back-Pressure Method in Studies of Gas Reserves. Part 2. J. W. Ferguson. *Petrol. Engr*, November 1941, **13** (2), 50.—The paper continues with discussion of White's method, and solves numerical examples fully, to reveal certain points in White's arguments. Four hypothetical cases have been chosen in which a range of values of C and n have been considered, such as would be likely to be encountered in actual practice. The composite curve has been calculated for each of these cases, and comparison made between the conventional curves and the curves obtained by White's methods. The errors in White's methods have been calculated for these four examples, which should be sufficiently general to cover the actual experience with well-curves as to prove the basic errors in his work. A. H. N.

259.* Subsurface Pressure Recorders and Equipment. H. G. Abadie. *Petrol. Engr*, November 1941, **13** (2), 69.—Details of a depth-pressure instrument are given, together with illustrations. Pressure admitted through the inlet port of the foot-piece acts on the end of the spring plunger and causes the extension of the spring. A stylus attached to the upper or free end of the spring records its extension on the longitudinal axis of a chart contained in a drum. Rotation of the chart-drum by means of a thermal motor or clock causes the stylus to be drawn laterally across the chart. The resultant trace of the stylus provides a record of pressures that may be correlated with the depths at which they were obtained.

It is a practice to run a combination mercury-filled sinker bar and thermometer well with the instrument. This assembly weighs 29 lb., is 92 in. in length overall, and has an O.D. of 1¼ in. The mercury-filled sinker bar is not standard equipment as supplied by the manufacturer. In lieu of a sinker bar, some operators run recorders in tandem, thereby obtaining check records, or at least one record, should the other for any reason be illegible. The instrument is easily and quickly assembled and dis-assembled. All pressure joints are of permanent bronze-to-steel fit. Details of each part of the instrument are given.

Chart-carriers are rotated by a thermal motor or clock. The motivating element and chart-drum comprise a unit.

The thermal motor consists essentially of a bimetallic helix, one end of which is connected to the carrier case and the other end to the drum-shaft. A change of temperature causes differential expansion of the metal strips of the helix, thereby rotating the shaft. For each degree rise in temperature the motor turns approximately 2½°. The position of the motor in the instrument shows that heat transfer from the well-bore must take place through four mediums before reaching the helical spring. In making the survey, this insulation insures an appreciable heat lag, and thus enables the motor to continue turning sufficiently to inscribe a well-defined lateral line each time the instrument is brought to rest. The thermal motor is therefore used in surveys where a temperature gradient can be utilized to actuate the motor. This means making a continuous traverse of a well from the surface to the bottom stop of the survey. Under optimum conditions, a survey consisting of eight stops may be made and still have all points legible. In general, only five or six stops may be

necessary to define fully the pressure traverse. The operator must exercise judgment regarding the time to be allowed at each stop, according to the rate of descent, status of well, stop programme, and anticipated temperatures.

The clock is used to advantage when it is necessary to make a large number of stops, when the stops are close together, or to obtain a time-pressure relationship. In a time-pressure survey the bomb is usually suspended at one point for the entire period. Clocks are available with running times to 72 hrs., and with various rates of rotation.

Calibration and field procedure are described in full. A. H. N.

260.* Small Gun Perforator Aids in Solving Production Problem. H. L. Flood. *Petrol. Engr*, November 1941, **13** (2), 90.—The paper deals with a small gun perforator designed for use inside tubing strings as small as 2 in. Its interest lies in the fact that it can be employed for a number of different purposes, not the least important of which involves getting out of trouble when the tubing string is stuck in the hole.

The external diameter of the gun-body is only 1¾ in. Until this gun was developed, no one had successfully designed so small a gun, because the thinking was still in terms of placing the powder charge horizontally, normal to the long axis of the gun. In a small gun the limited space prohibited use of a sufficiently large charge of powder to be effective. In the new gun this difficulty was circumvented by placing the powder charge vertically, parallel with the long axis of the gun.

The 1¾-in. gun perforator was developed in the West Texas area primarily in answer to the need for a means of perforating tubing for gas–oil ratio control purposes without the necessity of removing the tubing from the hole. In many of the older fields in West Texas canvas or other types of packers were installed in wells. Although these packers in many instances have served effectively for years, it is not economically feasible to re-run such packers, assuming that they could be removed without destroying them. The removal of these old packers has also proved to be a very costly operation in some areas, and after their removal difficulty has been experienced in obtaining another packer seat.

Although the method is not so widely used in other areas, in West Texas, following the leadership of one of the larger operators, it has been the practice for several years to pull the tubing string, and drill small orifices in the tubing collars. When the tubing is re-run, these drilled collars are spaced in the string, to serve as points of admission for gas from the annular space into the tubing, to aid in lifting the fluid.

Because the amount of gas admitted through even a small orifice represents a considerable volume, the holes drilled in the collars are not large. As a part of developing the 1¾-in. gun for this service, two new bullet sizes were designed, $\frac{1}{8}$-in. and $\frac{1}{4}$-in. in diameter, respectively. The largest bullet that can be fired from the small gun is $\frac{11}{32}$ in. in diameter. An important requirement in designing the small gun was to specify a powder charge having sufficient explosive energy to fire the bullet through one tubing wall without penetrating or damaging other tubing or casing strings.

The methods of perforating for gas admission and for freeing stuck pipe and other purposes are described. A. H. N.

261.* Some Aspects of Mechanical Pumping at Comodoro Rivadavia. E. M. Seifer. *Petrol. Engr*, November 1941, **13** (2), 116.—The formulæ giving rod acceleration and impulse loads, as well as the effect of viscosity of oil on pump-loads, are briefly discussed. The introduction of insert type of pumps has solved a number of pumping problems, and their use proved of value from the operating and economic standpoints. It is worth noting, in the case of the Escalante sector, where many wells the production of which by pumping with pumps of the common type encountered difficulties, that after being equipped with pumps of the insert type they operate normally.

Among the advantages of this type of pump it is shown that the time consumed in changing pumps shows an average of 32 hrs. for the common pump and 8 hrs. for the insert pump. This reduction in time has the following advantages: (*a*) The well is shut down for less time, and in consequence the loss of production is less. (*b*) The cost of the operation is less. (*c*) The efficiency of the hoists is increased now that each of them can attend to a larger number of wells. (*d*) Inasmuch as it is easier to change pumps, changes may be made more frequently, and therefore the production of the wells may be maintained. Other advantages are analysed.

The rod-hanger for use during the pulling and running-in of rods offers a number

of advantages: (1) An appreciable economy in time used in the operation is obtained. (2) The workers can manipulate the rods more easily. (3) The system is simpler, cleaner, and less dangerous. (4) The possibility that the threads may become covered with sand is minimized. (5) The construction of a concrete trough is not required. (6) Inasmuch as the rods are hung up, there is no danger that vehicles when arriving at the well will run over them. (7) The risk of bending, which is frequent when the rods are pulled and stacked in double stands outside the derrick without a hanger, is eliminated. The flexibility of the double stand puts considerable strain on the central joint, and is one factor contributing to the breakage of the pin. In this respect it is pointed out that in the "El Trebol" area all the fishing for rods that occurred in wells equipped with ⅞-in. rods has been caused by breakage at the pin.

Other items discussed are concrete floors for derricks, improvements in central power rod-lines, and heat treatment of auxiliary equipment. A. H. N.

262. Patents on Production. R. S. Charles. U.S.P. 2,266,000, 16.12.41. Appl. 7.10.40. Well-strainer with a soluble bonding material holding aggregates together.

A. Hollander and V. A. Hoover. U.S.P. 2,266,039, 16.12.41. Appl. 11.6.40. Submersible motor structure.

W. F. Tebbetts, Jr. U.S.P. 2,266,094, 16.12.41. Appl. 18.11.40. Hydraulic pump in combination with a well-tubing.

L. J. Vetrano. U.S.P. 2,266,289, 16.12.41. Appl. 3.4.39. Pump-operating mechanism, having a pair of cylinders of unequal cross-sectional area.

L. Spencer. U.S.P. 2,266,341, 16.12.41. Appl. 6.2.41. Gun perforator.

L. Spencer. U.S.P. 2,266,342, 16.12.41. Appl. 6.2.41. Gun perforator.

L. Spencer. U.S.P. 2,266,343, 16.12.41. Appl. 6.2.41. Gun perforator.

D. Staerker. U.S.P. 2,266,344, 16.12.41. Appl. 11.3.38. Coupling in combination with a well-pump.

G. F. Turechek. U.S.P. 2,266,345, 16.12.41. Appl. 19.2.41. Gun perforator.

A. J. Zschokke. U.S.P. 2,266,351, 16.12.41. Appl. 1.11.40. Gun-perforator construction.

A. J. Zschokke. U.S.P. 2,266,352, 16.12.41. Appl. 27.1.41. Gun perforator.

M. E. Chun. U.S.P. 2,266,355, 16.12.41. Appl. 29.10.40. Electrical generators for gun perforators.

C. J. Coberly. U.S.P. 2,266,356, 16.12.41. Appl. 18.5.38. Automatically governed pump to control rate of flow of high-pressure fluid.

P. M. Rea. U.S.P. 2,266,384, 16.12.41. Appl. 9.11.39. Polish-rod packing of resilient nature.

J. M. Hait. U.S.P. 2,267,459, 23.12.41. Appl. 9.1.39. Deep-well pump with a sand-trap.

E. Berl. U.S.P. 2,267,548, 23.12.41. Appl. 31.1.36. Art of extracting oil from the earth by means of soluble substances.

R. R. Thompson. U.S.P. 2,267,627, 23.12.41. Appl. 19.10.40. Gun perforator.

L. C. Chamberlain. U.S.P. 2,267,855, 23.12.41. Appl. 15.3.37. Treatment of wells producing mineral fluid.

R. P. Grayson. U.S.P. 2,267,910, 30.12.41. Appl. 25.11.39. Power-producing apparatus, being a fluid-operated motor for a well-pump.

R. A. Lamb and W. H. Waring. U.S.P. 2,268,041, 30.12.41. Appl. 4.2.39. Flow device for wells.

C. J. Coberly. U.S.P. 2,268,543, 6.1.42. Appl. 18.7.32. Method of assembling fluid-operated pumps.

J. H. Whitehead and C. Mathiesen. U.S.P. 2,269,046, 6.1.42. Appl. 12.7.38. Apparatus for screening sand and gravel mixtures.

P. T. Tarnoski and E. H. Uhlmann. U.S.P. 2,269,134, 6.1.42. Appl. 2.6.39. Desalting and demulsifying compound for petroleum emulsions.

H. R. Downs. U.S.P. 2,269,189, 6.1.42. Appl. 20.3.39. Fluid-pump with fluid-driven motor.

M. Williams. U.S.P. 2,269,569, 13.1.42. Appl. 27.9.39. Process for analysis of core-samples containing oil and water by means of an absorption train and a heating coil.

C. M. O'Leary. U.S.P. 2,269,729, 13.1.42. Appl. 23.12.40. Pitman gearing.

C. M. O'Leary. U.S.P. 2,269,730, 13.1.42. Appl. 5.3.41. Central power.

W. E. Saxe. U.S.P. 2,269,787, 13.1.42. Appl. 9.4.40. Counterbalancing apparatus for pumping wells, with adjustable counterbalance.

B. F. Schmidt. U.S.P. 2,269,789, 13.1.42. Appl. 28.9.37. Fluid piston-pump for deep-well pumping.

W. W. Kemphert and D. E. Tessendorf. U.S.P. 2,269,821, 13.1.42. Appl. 16.10.40. Sheave for use in a power-transmission drive.

H. T. Kennedy. U.S.P. 2,270,006, 13.1.42. Appl. 17.4.37. Sealing porous formation by injecting a polyvalent metal the oxides and hydroxides of which are insoluble.

J. O. Steele. U.S.P. 2,270,146, 13.1.42. Appl. 13.3.40. Well-pump for shallow wells, possibly applicable to water wells only. A. H. N.

Gas

263.* Developments in the Use of Natural Gas Fuel in Italy. E. A. Bell. *Petrol. Times*, 29.11.41, **45** (1157), 700.—It is believed that the total domestic natural gas (methane) yield reached a figure of 26,000,000 cub. m. in 1940, and that this source, together with gas produced by the metallurgical industry, will yield a supply of about 40 million cub. m. in a not too distant future.

The great handicap in the utilization of this supply as a motor fuel, however, is the general uncertainty of location of the more important gas deposits, and in the rapid exhaustion of some of the wells even in the most important zones.

A further handicap is that the consuming centres are generally too far distant from the producing areas. Distribution also gives rise to great difficulties, since the cylinders used, whether of molybdenum steel or of aluminium–magnesium, are too few in numbers and their production has been curtailed.

The question of developing an extensive pipe-line system has recently been considered, but the financial outlay can be risked only where the yield is regular and not likely to cease altogether within a short time.

A number of short pipe-lines such as Pietramela (31 miles from Bologna) to Florence—34 miles long; pressure 25 atmospheres; Podenzano to Piacenza—10 miles—25 atmospheres pressure are in existence, but no long pipe-lines have as yet been constructed. This, however, is under consideration.

Liquefaction has been discussed as a solution to the problem, but no success has yet been achieved on a commercial scale.

The effort to develop the use of methane over a wide field is handicapped by the uncertainty as to the post-war position in regard to Italian fuel supply. It is possible that gas will then revert to the rôle it played before the war within the chemical industries, and that its use as a motor fuel will decline. D. L. S.

Refining and Refinery Plant

264.* New Chart Solves Heat Transfer Calculations for Fluids in Viscous Flow Region. D. O. Hubbard and J. V. Roth. *Chem. Met. Eng.*, January 1942, **49** (1), 100.—A method of correlating heat-transfer data in the viscous flow region, which is of special significance in the petroleum industry, where transfer in this region is commonly experienced, is presented here. When fluid flows through a pipe in viscous flow, its viscosity at the heat-transfer surface varies widely from the average viscosity. Sieder and Tate (*Industr. Engng Chem.*, 1936, **28**, 1429) introduced a corrective factor which

takes into account the viscosity gradient by means of the ratio μ_a/μ_w—that is, the ratio of average viscosity of the main fluid stream to its viscosity at the temperature of the tube wall.

The mathematical relationship is :

$$G = \frac{hD}{12K}\left(\frac{2{\cdot}42C_p\mu_a}{K}\right)^{-\frac{1}{3}}\left(\frac{\mu_a}{\mu_w}\right)^{-0{\cdot}14}$$

A. H. N.

265.* War-Time Protection of Industrial Plants. Anon. *Chem. Met. Eng.*, January 1942, **49** (1), 102–108.—The paper deals specifically with sabotage and its prevention, protection against incendiarism and against air raids, all discussed from the viewpoint of chemical plants. The conclusions reached are : Sabotage by fire is the most dangerous of all war-time enemies of American chemical and process industries. Fortunately, protection against such damage can be had by strict adherence to orthodox methods of fire prevention, although it will be necessary to double and treble normal peace-time measures. Common sense and stern precautionary steps are the best protections against all types of sabotage and espionage of industrial chemical and process plants.

Enemy air raids may consist of efforts to cripple or destroy certain industrial plants by the use of incendiary bombs. Magnesium incendiaries are relatively harmless if properly understood and fought. A fine spray of water can quickly extinguish them and prevent damage in most cases. However, it is first necessary to have proper equipment in sufficient quantities, properly trained personnel, and many sources of water, in order to fight such bombs successfully.

Reasonable protection of equipment and personnel from distant effects of high-explosive bombs can usually be obtained from light-weight shutters and other simple methods. Black-outs can best be accomplished by the use of proper screens or baffles, although most plants require individual study before protective steps are taken.

A. H. N.

266.* Alloy Steel Characteristics for Oil-Refinery Service. W. G. Hildorf. *Nat. Petrol. News*, 3.9.41, **33** (36), R. 275.—The article sets forth the characteristics which steel must possess if it is to be satisfactory for high-temperature service, and indicates how these characteristics may vary in different applications. The more common alloying elements are classified according to their effect on the steel, which effect is shown to be specific. Certain elements tend to produce a two-phase structure. If this is undesirable, the so-called ferrite and austerite formers must be balanced, so that the resulting steel is single-phased. The number of steels now available is large, but a need for steels capable of withstanding still higher temperatures in service exists. This is particularly so for continuous service at 1500° F. and higher, and also at lower temperatures where the permissible deformation is of a small order.

H. G.

267.* Hot Clay Treatment for Removal of Sulphur from Gasoline. H. Bottomley. *Nat. Petrol. News*, 15.10.41, **33** (42), R. 330.—The paper discusses the five principal processes for the removal of sulphur bodies from gasoline. The hot clay process is applicable only to straight-run products. With cracked gasolines some polymerization occurs, to the detriment of the product. Tabulated data indicate that in the hot-clay process mercaptan sulphur is removed completely, and that the total sulphur content is reduced to a lower figure than by the other process in the case of the examples chosen. If judged either from the point of view of T.E.L. savings or by the appreciation of quality, the process is indicated to be very attractive economically.

H. G.

268.* Precise Commercial Fractionation in 1000 Barrel Stedman Unit. L. B. Bragg and F. Morton. *Nat. Petrol. News*, 12.11.41, **33** (46), 355.—Trinidad Leaseholds, Ltd., required a distillation unit capable of producing a number of well-fractionated cuts from light petroleum distillates. A continuous-distillation battery containing a number of bubble-tray towers was first considered, but the scheme was abandoned in favour of a batch-distillation unit.

It was decided to use a packed column, and Stedman packing was chosen because it has a lower hold-up than other packings of equal capacity and plate efficiency.

The unit was designed to operate on debutanized light gasoline f.b.p. 248° F., and to separate this into seven overhead fractions and a still residue. The odd-numbered fractions were to contain substantially all the *iso*paraffins, naphthenes, and aromatics, while the even numbers and residue were to contain substantially all the normal paraffins.

The unit consisted primarily of a still, heated by internal steam coils, a Stedman packed column, a horizontal overhead condenser, a reflux distributor, and the necessary product and residue coolers. Drawings and a full description of the unit are included in the paper.

The packing used in the column had a fractionating ability corresponding to about four theoretical plates per foot of height, and the packed portion of the tower was 7 ft. in height. The liquid and vapour hold-up under operating conditions amounted to approximately 25 brl.

Three different types of operation of the unit are described, and in all cases the still was first charged with 1000 brl. feed-stock, steam being then admitted to the heating coils at the desired predetermined rate. One set of data indicates that a naphtha cut (212–273° F.) might be separated to provide one fraction (219–250° F.) containing 34% toluene (b.pt. 231° F.). D. L. S.

269.° Mixed-Solvent Extraction. A. V. Brancker, T. G. Hunter, and A. W. Nash. *J. Inst. Pet.*, January 1942, **28** (217), 15–25.—Experimental work is discussed. The conclusions reached are that when the refining, by the batch extraction of a stock of fixed composition, produced by a single solvent only partly miscible with the stock and by a binary solvent mixture consisting of the same solvent as principal solvent, together with an auxiliary solvent completely miscible with both stock and principal solvent, is compared, the following results are obtained: (1) At equal solvent/stock ratios better-quality raffinates are obtained with the single solvent than with the mixed solvent. The addition of auxiliary solvent to the principal solvent results in a decrease in the quality of the raffinate produced. (2) At equal solvent/stock ratios better yields of raffinates are obtained with the single solvent than with the mixed solvent. The addition of auxiliary solvent to the principal solvent results in a decreased yield of raffinate. (3) A better yield of higher-quality raffinate is obtained by the use of a single solvent than would be obtained by the use of mixed solvent of the type being considered. (4) At equal principal solvent/stock ratios an increase in the amount of auxiliary solvent present in the mixed solvent results in a decrease in both quality and yield of raffinate. A. H. N.

Gas, Diesel, and Fuel Oils

270.° Evaluation of Diesel Fuels in Full-Scale Engines (Co-operative Fuel Research Committee Report). W. G. Ainsley. *J. Soc. Aut. Engrs*, 1941, **49** (4), 448–460.—The Full Scale Engine Group (C.F.R.-Automotive Diesel Fuels Division) was organized to clarify the issue of fuel specifications by engine tests. Tests were made on four representative fuels in fifteen engines of seven different makes. The effects studied were: engine deposits, smoothness, starting, smoke, power output, consumption, and odour of exhaust.

It is concluded that ignition quality affects starting and smoothness, and to a lesser extent carbon deposits, smoke, and exhaust odour. High-ignition quality gives an improvement in all these factors. The more volatile the fuel the less smoke and combustion-chamber deposits. A higher specific gravity gives better volumetric fuel consumption, power output being a function of calorific value per pound. Gravity, viscosity, carbon residue, and flash point are all related to volatility, and consequently show effects on exhaust smoke and combustion-chamber deposits which may or may not be independent effects.

Viscosity has some effect on smoothness and smoke, an increase being detrimental. It also involves consideration of ease of circulation, atomization, pump plunger leakage, etc. The carbon residue on 10% bottoms (A.S.T.M.) correlates with engine deposits and smoking tendency.

An appendix offers recommendations for a specification for a universal diesel fuel suitable for mobile Army and certain high-speed Navy equipment. The following is a summary:

Viscosity, 33–43 sec. Saybolt at 100° F. 31 secs. minimum for temperatures below +10° F.
Volatility, 90% point, 650° F. max.
End point, 700° F. max.
Flash Point, 140° F. min.
Carbon Residue on 10% bottoms (A.S.T.M. Method D-189–39), not exceeding 0·15%.
Ignition Quality, 47 cetane, min.
Pour Point, 0° F. max. for average daily minimum temperatures above +10° F.
Sulphur, 1% max.
Corrosion, 3-hr. copper strip test at 212° F. K. A.

Lubricants and Lubrication

271.* Reclamation of Lubricating Oil in Britain a National Necessity. R. B. Hobson. *Petrol. Times*, 15.11.41, **45** (1156), 659.—The recovery of used lubricating oil on a large scale is advocated as an essential feature of the country's war effort. It is pointed out that processes which include only the mechanical separation of solids and water are unsuitable because the diluent remains in the oil. In a process described, the oil, after blending and settling, is distilled in batch stills in the presence of a substance which coagulates colloidal contaminants and removes acidic and oxidized bodies. Tabulated data representing diesel engine oil, turbine oil, transformer oil, general motor-transport oil, and aircraft oil (D.T.D. 109) before and after treatment indicate that satisfactory recovery is achieved. Yields are indicated to be at least 85% vol. H. G.

Asphalt and Bitumen

272. Metal Protection with Asphalt. Anon. *Chem. Trade J.*, 31.10.41 (109), 218.—Asphaltic bitumen dissolved in a light spirit and emulsified with emulsifiers containing "passivating agents" among which are potassium dichromate, barium chromate, sodium silicate, and a mixture of sodium nitrate and rosin. Fine sand and cement are mentioned as additives. Only multi-layer coatings are said to be effective. H. G.

273.* Uses and Testing of Gunned Asphalt. D. C. Broome and L. Bilmes. *J. Soc. chem. Ind.*, 1941, **60**, 146–153.—For use in the building industry gunned asphalt, essentially a blend of bitumen with fine mineral matter, has been developed to replace the more tediously applied mastic asphalt. The asphalt blend is pulverized and applied by means of the Schori flame-gun, using compressed air, the mixture passing through a flame of propane and oxygen. The thickness can be regulated, and ¼–½ in. is most suitable; the temperature at impingement does not exceed 150° C., thus avoiding overheating of the bitumen. The asphalt requires a thin base course, consisting of emulsion or cutback, even on dry surfaces. Seventeen applications, tried already and found satisfactory, are given. The principal factors affecting the success of the process are the relative caking value of the powdered materials before and after storage, the flow properties of the asphalt immediately after passage through the gun, the degree of adhesion obtained on bases of various types, etc. The asphalts are made as soft as is consistent with non-caking, pulverization, and avoidance of "sag" after application. The characteristics of suitable bitumens, softening points 88–96° C., are discussed, and careful blending with "oxidized" bitumens is practised. A mineral powder, generally silica, is ground to give about 80% passing 300-mesh B.S. sieve and 99% through 100-mesh. A certain percentage of "separator" (unspecified mineral matter) is added to prevent caking, particularly on storage; this appears to act by coating the bitumen particles, thus preventing adhesion under pressure. A caking test is described as well as a test for flexibility after gunning. The fundamental rheological properties are touched on, but are described in full in a later paper. Impact tests described are used to determine whether the material

will withstand sudden shocks and still adhere after gunning. The most satisfactory test is one in which a strip of gunned asphalt is clamped so that 5 cm. is free, and is then struck by a rigid weighted pendulum, and the amount of "follow through" readily gives the work done in fracturing the asphalt. The paper also includes a preliminary study of permeability, and it is shown that a good gunned asphalt is impermeable to 90 lb./sq. in. water pressure. It is resistant to 30% concentrated hydrochloric and sulphuric acids, 20% nitric acid, and to any concentration of phosphoric acid if silica is used as the mineral in each case. H. G. W.

Detonation and Engines

274.* Heat Transference in Internal Combustion Engines. Anon. *Gas Oil Power*, October 1941 (36), 193.—A study of the heat loss from I.C. engines shows that the subject of heat transfer from engine cylinders is more involved than in other heat exchanges because of the large cyclic variations taking place.

During the suction stroke the cylinder gases or air are at almost constant temperature. Compression raises the temperature of the charge by an amount depending on the rate of heat transference from the heated charge. Combustion presents numerous complex conditions, depending on the rate of flame growth, flash point, and calorific value of the charge, etc. During expansion the phenomenon is greatly simplified, although even then the problem is by no means a simple one.

Most heat is lost from the charge during combustion and the subsequent parts of the cycle. During the first stage of combustion, when activation of a minute charge in the immediate vicinity of the seat of ignition takes place, the flame nucleus gains heat from the combustion process and transmits it by radiation. The second stage is described as the condition when, after a "delay" period, the flame grows until all combustible vapour has been consumed.

Heat transference during the expansion stroke is seriously affected by variations in the gas temperature, surface area, specific heat, and density of the working gases. Specific heats change considerably with temperature, and the density of the gas during the expansion stroke varies according to the law of expansion, and thus rather complicated relationships are involved. Heat is transmitted from the hot gases through the cylinder walls, head, and piston crown, and it is necessary to regulate the coolant supply to the cylinder walls to avoid distortion due to irregular expansion. It has been shown that the intensity of temperature variations decreases rapidly as the thickness of the wall increases, until at a depth of $\frac{1}{4}$ in. the temperature oscillations due to cyclic variations of temperature in the cylinder practically die out.

The question of air cooling of engine cylinders is discussed, and a formula is given for calculating the fin area necessary for efficient cooling under certain given conditions.

As regards liquid cooling of cylinders, the question of radiator design is not discussed in detail, but it is indicated that there is an optimum water circulation rate above which the rate of heat dissipation increased only very slowly. D. L. S.

275.* Supercharging the Compression-Ignition Engine. C. B. Dicksee. *J. Instn Auto. Engrs*, 1941, **10** (1), 1–27.—The power developed by any I.C. engine is dependent on the quantity of air utilized and the thermodynamic efficiency. One method of increasing the rate of air supplied is supercharging. Many engines to which supercharging has been applied were not designed with this end in view, and it is therefore necessary to limit the maximum pressure of combustion.

Usually a proportion of the fuel is burnt at constant volume, and the remainder at constant pressure, the latter entailing some loss of efficiency. The proportion burnt at constant volume, and hence the maximum efficiency, will be determined by the maximum pressure which can be tolerated. The author analyses the P, V, T relationship for the working fluid, and concludes that for optimum output and economy the highest compression ratio capable of developing the desired output should be used. The maximum pressure should be the highest which existing conditions permit.

The net output is profoundly influenced by the type of blower used and its efficiency. The economic limit for the Roots type is a boost ratio of around 1·5. For maximum fuel economy the expansion ratio in the power cylinder should be as high as possible consistent with the ability to develop the desired output. K. A.

276.* Mercedes-Benz DB-601 A Aircraft Engine. R. W. Young. *J. Soc. Aut. Engrs*, 1941, **49** (4), 409–431.—Several of these engines have been made available in the U.S.A., and this paper is a detailed description with illustrations and comments. Performance is compared with that of other well-known liquid-cooled types. German and French designs tend towards larger displacement and lower speed for a given power than British and American practice. Among features of special interest on the DB-601 A are the Bosch fuel-injection system and the supercharger fluid drive, which automatically adjusts the boost during climb. The power output at sea level and altitude, fuel consumption, and weight are on a par with contemporary power plants of the same general type. K. A.

277.* Engineering for Better Fuel Economy. H. T. Youngren. *J. Soc. Aut. Engrs*, 1941, **49** (4), 432–441.—This paper reviews ten years' experience in developing one make of American car to give better fuel economy in spite of the demand for increased performance and the rising trend of car weight. The author is confident that further progress can be achieved.

Appreciable economies can be effected through weight reduction, provided the axle ratio is adjusted to maintain a constant performance factor; rolling and wind resistance are major factors in economy. Specific fuel consumption at road load is much higher at part-throttle low car speeds than at wide-open throttle. This is due to the lower percentage of power output in proportion to engine friction. It appears that an attempt to reduce engine friction deserves much effort. In the engine under consideration the apparent pumping loss is the largest component of total friction. Pistons and rings are a large contributor.

Higher compression ratios will continue to be contributing factors to better fuel economy, given suitable high-octane fuel. To realize the full potential gain in economy, advantage of the power gain from increased compression ratio must be taken to reduce either engine size or speed. At 40 m.p.h. an increase from 65 to 100 octane number allowed a 25% improvement with the same axle ratio and a 40% improvement with the axle ratio modified to maintain the same low-speed performance. Instead of reducing the axle ratio a smaller engine could be used, but comparative data show a marked superiority in economy for the larger engine running slower, particularly at the higher vehicle speeds.

Another well-known factor in fuel economy is air/fuel ratio. The trend in recent years has been towards ratios of about 15 : 1. Beyond this the field needs further exploration. Fuel injection with a stratified charge may offer a means of further progress. Improved operation at lean mixtures might be obtained with greatly advanced spark timing. At wide-open throttle, with a mixture ratio of 19·2 : 1, the spark was advanced to 80° B.T.C. for maximum power. Improved scavenging also aids the utilization of part-throttle lean mixtures to reduce consumption.

At part loads a wider than normal spark-gap promotes economy and steady operation over a wider range of air/fuel ratios. With a wide gap the discharge lasts longer and is multiple or oscillatory rather than a single arc. This increases the probability of ignition. A higher-capacity coil is necessary.

A high axle ratio gives improved miles per gallon at the expense of hill performance and acceleration. Automatic transmissions provide increased economy or increased performance, as the occasion warrants, without violating the American public demand for non-manual gearshift performance. K. A.

Coal and Shale

278.* Development of Alternative Fuels in Sweden. Anon. *Petrol. Times*, 15.11.41, **45** (1156), 674.—Blockade conditions have cut off Sweden's fuel oil imports completely, and considerable progress has been made in the production of substitute fuels. Large numbers of vehicles are now running on producer-gas, wood being the fuel. Smaller numbers use, acetylene, illuminating gas, methane, or electric power. The production of shale oil is being developed under State sponsorship. Heavy and light fuel oil, gasoline, and sulphur are being produced from this source. Shale-oil production cannot compete on a cost basis with imported fuel except under the present conditions. It is estimated that proved reserves of shale are sufficient for the country's needs for 500 years, but its development must obviously depend largely on political considerations. H. G.

Economics and Statistics

278.* **Petroleum's Past, Present, and Future.** R. P. Russell. *Chem. Met. Eng.*, January 1942, **49** (1), 84–85.—The petroleum industry in the United States in 1941 will have refined about 1,400 million brl. of crude oil, which is at the rate of about 200 million tons/year. About 44% by volume of the crude run to stills will wind up as gasoline, making the 1941 gasoline production approximately 90 million tons. This gasoline will be sold at about $16/ton as it leaves the refinery. The steel industry, which is generally looked on as the greatest of the "tonnage" industries in 1941, will make about 84 million tons of steel, which will sell at the mill gates for approximately $38/ton. Aluminium tonnage amounts to about 1/150th of the gasoline tonnage.

In the refining of oil, rapid advances in the technology of chemical engineering have made it possible to produce increasingly greater yields of more valuable products, and at the same time effect substantial improvements in quality. Twenty years ago gasoline yields on crude were 26%, whereas to-day they are 45%. Over this period crude runs have increased four-fold and gasoline production has increased seven-fold. Quality has steadily improved to meet the requirements of high compression motors characterized by improved performance and economy. Accepting A.S.T.M. octane number as a measure of anti-knock quality, the average gasoline supplied to the American public in the last 16 years has increased from approximately 50 octane number to 73 octane number to-day, accompanied by increase in volatility to improve starting and acceleration. In regard to aviation fuels, the development of 100 octane gasoline has given an increase of approximately 20% over the 87 octane grades in commercial use at present, and an increase of 50% over the 70 octane gasolines in use 10 years ago.

Prices are compared as they exist to-day and as they were 20 years ago. The future of catalytic cracking is considered to be of vital importance. A. H. N.

BOOKS RECEIVED

Institution of Chemical Engineers. Transactions. Vol. 18 (1940). The Institution. 10¾ in. × 8½ in. 147 pp.

Contains six papers read to the Institution in 1940 and the address of the President (Mr. F. Heron Rogers) on "Oil." The latter contains some interesting illustrations, including a reproduction of a poster issued by Messrs. Carless Capel and Leonard in 1899, claimed to be the first appearance of the word "petrol." A lengthy paper by E. Owen summarizes the methods of measuring the flow of liquids and gases.

Institution of Mechanical Engineers. Proceedings. Vol. 145 (January–June 1941). The Institution. 11¼ in. × 8¼ in. 252 pp.

Dr. S. F. Dorey's historical survey of the classification of ships and its influence on marine engineering is included in this volume, which also contains papers of topical importance on Munitions Labour Supply Organization, Acceptance Test Charts for Machine Tools, and Gun Run-up Springs. The Institution is to be congratulated on maintaining its pre-war high standard of paper, printing, and general appearance of its *Proceedings*.

Institution of Automobile Engineers. Proceedings. Vol. 35 (1940–41). The Institution. 8¾ in. × 5¾ in. 312 pp.

Two papers of particular interest to the petroleum industry are T. C. Worth's "Notes on Filtration and Distillation of Lubricating Oil," and W. Allen's "Notes on Tests of Creosote Mixtures in C.I. Engines." (A small error noted in Mr. Worth's paper was a reference to the "Institute of Petroleum Technology's handbook.")

U.S.A. **Supreme Court. Report of Proceedings in the Case of the Standard Oil Companies of New Jersey, 1909–10.** Verbatim report of the Standard Oil case, copies of the brief, list of witnesses, etc., 25 volumes. (*Presented by Messrs. Whitehall Securities Corporation, Ltd.*)

The Modern Diesel. J. Iliffe & Sons, Ltd. 6th edition, 1941. 7¼ in. × 5 in. 238 pp. 5*s.* nett.

The sixth edition of this handy summary of first principles and engine types, the first edition of which appeared in 1930, has been extensively revised and brought up to date to 1939. Subsequent developments are necessarily omitted owing to absence of published information. Road and rail transport, aircraft and marine diesel engines are all discussed, and frequent comparisons made between British, American, and German pre-war practice.

High-Speed Diesel Engines. Arthur W. Judge. 4th edition, 1941. Chapman & Hall. 8¾ in. × 5½ in. 536 pp. 25*s.*

A review of the 2nd edition of this book (*J. Inst. Petrol. Tech.*, **23**, 1936, 31A) referred to it as "dealing very comprehensively with the whole subject in a way calculated to be of the most use to the student from a theoretical and practical point of view," and offered one or two constructive suggestions for the chapter on fuel and specifications. The 4th edition, to which over 100 pages have been added, preserves the balance between the experimental and theoretical aspects and the purely descriptive side, and incorporates much up-to-date information on fuel-injection systems and new types of two-cycle engines. The chapter on fuels has been considerably extended. It now covers work published up to 1939 on diesel index, cetane and cetene numbers, and ignition quality tests, as well as recent specifications, including an approximate specification for Pool Diesel Oil.

Junior Institution of Engineers. Journal. Vol. 51 (1940–41). Percival Marshall & Co. 8¾ in. × 5½ in. 308 pp.

This volume maintains the standard of its predecessors in providing short informative papers on many unusual aspects of engineering ranging from "Tide Mills" to "Electrical Music." The Presidential Address by Viscount Falmouth reviews the engineer's rôle in war.

A.P.I. Specifications. Additions and Supplements. November 1941. Obtainable from the American Petroleum Institute, Division of Production, 1205 Continental Buildings, Dallas, Texas, U.S.A., and 50 West 50th St., New York (not stocked by the Institute of Petroleum).

The following specifications have been received:

Casing, Drill-pipe and Tubing. Supplement No. 1 to A.P.I. Std. 5-A (11th edition). August 1941.

Setting Depth Properties of Casing. 1st edition A.P.I. Code 5-C-2. August 1941.

Line-pipe. Supplement to A.P.I. Std. 5-L. August 1941.

Oil-well Pumps. 6th edition A.P.I. Std. 11-A. October 1941.

Information on A.P.I. Std. 11-A. September 1941.

Steel Geared Speed Reducers. 4th edition. A.P.I. Std. 11-E. August 1941.

Chain-drive Speed-reducers. 2nd edition. A.P.I. Std. 11-E-1. August 1941.

Rating of Hoisting Tools. 2nd edition. A.P.I. Std. 11–9. August 1941.

Endeavour. Quarterly periodical published by Messrs. Imperial Chemical Industries, Ltd. Vol. 1, No. 1, January 1942. 11 in. × 8½ in. 48 pp. (At present only available for export, owing to restrictions on paper supply.) 5*s.*

The purpose of this new periodical is to lay emphasis on British science. A Foreword by Sir William Bragg is accompanied by messages of goodwill from other distinguished British scientists. These are followed by ten articles on scientific subjects and four pages of book reviews. Prof. John Read, F.R.S., contributes a short note on the library of James Young, now housed at the Royal Technical College, Glasgow, and the bibliography of this library prepared by Prof. D. Ferguson. A note by Dr. J. W. Baker on "Work in Progress" deals with polar effects of alkyl groups.

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Geology and Development.

280.* Hombre Pintado, Venezuela. G. W. Halse. *J. Inst. Petrol.*, February 1942, **28** (218), 36–40.—The topography and geology of this field are discussed after a brief *résumé* of its development. The country contains precipitous and impassable hills. Surface geology had been mapped as a fairly simple anticline in the form of a crown of a structure sheared off its flanks. Difficulties met in certain localities are discussed.

A. H. N.

281.* Exploitation of Deep Pays Offers Rich Possibilities. W. V. Howard. *Oil Gas J.*, 5.6.41, **40** (4), 24.—Experience has shown that if oil is found at relatively shallow depths on a structure, there is more than an average chance that lower pays will also be found on that structure. Although some argue that this is due to the upward movement of oil from one pay to another, marked differences in the composition of the oils seem to deny this, and point to the recurrence of oil-forming conditions in the locality.

In California the finding of oil in a lower pay on one structure almost invariably leads to deeper drilling on neighbouring structures, while no salt-dome structure on the Gulf Coast can be considered barren until its flanks have been tested to the level of the lowest pay in the district.

In West Texas 1,000,000 brl. of oil have been produced and the Permian has reserves of 2,500,000,000 brl., but it is clear that beneath the Permian there is an Ordovician basin which may be equally important, and possibly more extensive. A Silurian pay has been found on the western rim of the basin, and a Mississippian lime pay in Young and Archer counties.

Improvements in equipment and technique have rendered this deep testing possible, and made the drilling of a 20,000-ft. well a distinct possibility. There have been comparable advances in production technique.

The Los Angeles and neighbouring basins, the San Joaquin Valley, the Gulf Coast, and the Anadarko basin of Oklahoma are areas with producing or potentially producing beds below 10,000 ft. Other areas, such as the Rocky Mountain States and the Northern Great Plains, have over 10,000 ft. of sediment, but little is known about conditions at depth upon which to assess the potentialities.

The results of deep drilling in various regions and the prospects are briefly discussed.

G. D. H.

282.* Well Logs and Field Data of Prospective Oil Areas—North-west Kansas. Anon. *Oil Gas J.*, 5.6.41, **40** (4), 96B.—The area south and south-west of the Central Kansas uplift is little developed at present. On this feature producing trends have been drilled on the high, with more or less scattered wild-catting down the flanks later. West of the Burnett pool in Ellis County there are only a few isolated producing areas, for lack of pipe-lines and low allowables have kept down developments in the more remote districts.

The Central Kansas uplift rose fairly continuously during the Palæozoic, with greatest uplift following the deposition of the Mississippian lime, and leading to exposure of the granite. The uplift was later covered by Pennsylvanian and Permian beds. Mesozoic and some Tertiary beds were also deposited.

Oil has been produced from the Arbuckle, Lansing-Kansas City, Mississippi lime, and granite wash. It seems possible that the Sundance, Morrison, and Cretaceous may be productive in Western Nebraska, and even in Western Kansas. Some fields appear to be associated with cross-trends over the uplift, but the structural relationships of others are not clear.

A map and a series of well sections are appended.

G. D. H.

283.* Unconformities Complicate Exploration for Deep Pays. W. V. Howard. *Oil Gas J.*, 5.6.41, **40** (4), 109.—Slight unconformities give rise to wedging beds, and major unconformities give buried structures which have an indirect or no relation to the surface structures.

Two of the deepest basin areas in U.S.A. have thick sedimentary sections without major unconformities—California and the Gulf Coast, but there are many minor unconformities, and the marine oil-bearing formations commonly do not outcrop. Prospecting for deeper horizons in these two areas is a matter of finding gentle anticlines,

wedge-edges due to (1) pinching out of formations along old shore-lines, (2) facies changes, (3) erosion of a porous horizon and later burial beneath an impervious cap, steep structures due to pronounced folding or salt intrusions, and structures of any of the above types under an overthrust fault.

In the Mid-Continent area there is a great regional unconformity, but there is a reflection of the structure of the old beds in the younger beds, causing Ordovician pays to underlie Permian or Pennsylvanian production.

When erosion of an old land surface destroys all evidence of structure, and later movements take place along other axes the search for oil-pools is very difficult. Such a condition may possibly obtain in parts of the Appalachian basin. G. D. H.

284.* Northern West Texas Play Finds Production in New Pays. D. H. Stormont. *Oil Gas J.*, 1.1.42, **40** (34), 60.—Fourteen wildcats are drilling or preparing to drill in the north basin, and ten were completed in the past month, one of them finding commercial production, and thus extending the area's productive limits 40 ml. to the north and east. A wildcat now drilling shows signs of commercial production at a point 30 ml. east of the recent Lubbock discovery. In North-western Dawson County a small pumper seems assured, and in Gaines and Hockley Counties two wildcats are showing possibilities.

In the north basin the Permian pays were believed to lack porosity for giving commercial production, but the development of Wasson, Slaughter, and Seminole, fields of considerable size and with high well potentials, shows that the area was under-rated. The massive limestones of the south appear to be absent in this region, and there seems little likelihood of pre-Permian (mostly Ordovician) production. The frequent alternations of marine and evaporite deposits in the Permian adds to the number of possible pays in the north basin. Production has been found in San Andres and Clear Fork beds.

The Wasson field covers 58,000 acres, and Slaughter's productive area is even larger.
G. D. H.

285.* Proven Reserves. W. V. Howard. *Oil Gas J.*, 29.1.42, **40** (38), 60.—Estimated proven oil reserves in the U.S.A. are 20,299,542,000 brl., 200,285,000 brl. more than on 1st Jan., 1941. There were 341 discoveries, new fields, or new pays in 1941, representing 486,935,000 brl. of proven reserves, 135,046,000 brl. more than in 1940. Extensions to old fields added 1,009,175,000 brl. to the reserves. Revision of old estimates added only 95,719,000 brl. of oil. Of the thirty-three districts into which the oil production can be divided, seventeen showed reduction in reserves in 1941, and changes in production rates gave eighteen districts a smaller reserve in terms of years' supply.

Texas leads with 669,290,000 brl. of new oil, although four districts in Texas show a decline in reserves. California's reserves declined slightly as compared with 1940, and in some of the San Joaquin Valley fields suffered a sharp downward revision. Oklahoma's reserves also declined. There was a big addition to Illinois reserves as a result of the discovery and extension of prolific Chester and McClosky pools. Michigan, after a poor showing in the first half of 1941, had a good second half, in which most of the new fields discovered were north of the old producing belt.

There was considerable development of the Smackover lime, in Arkansas.

A table gives by States or districts the estimated reserves on 1st Jan., 1941, and 1st Jan., 1942, the amounts attributable to discoveries and extensions in 1941, the production during 1941, and the change in the reserve position, as well as the reserves in terms of years' supply.

A series of maps show the location of new fields and extensions, while the proven acreage, formation thickness, and estimated reserves are tabulated.
G. D. H.

286.* Production Record Reached in 1941 with Trend Still Up. W. V. Howard, *Oil Gas J.*, 29.1.42, **40** (38), 74.—1941's oil output in U.S.A. was 1,391,544,457 brl., 4% above the 1940 figure, and averaged over 4,000,000 brl./day during the last three months of the year. The leading State, Texas, had a production rise of only 1·5%, California's output rose 3%, and that of Oklahoma 1·5%, while Illinois declined by 13%. Rises of 12%, 18%, 25%, and 16% were shown by Louisiana, Kansas, Arkansas, and Wyoming, respectively. The production records of the seventy-five largest fields show an overall

fall of 44,500,000 brl. as compared with 1940, although practically the whole of the decline can be accounted for by Salem's fall from 70,734,313 brl. to 29,538,803 brl. Forty-one of the leading pools are over ten years old, and the indications are that the leading pools are not able to take care of any increased demand, except in the case of East Texas if sound practice is ignored. /

Tables give the annual production by States for the period 1932–41, and the production of the seventy-five largest fields in 1940 and 1941. The trends and future prospects of these fields are noted. G. D. H.

287.* Record Demand in 1941 Met by Increase in Completions. W. V. Howard. *Oil Gas J.*, 29.1.42, **40** (38), 76.—32,140 wells were completed in U.S.A. in 1941; 22,005 were oil-wells, 3014 gas-wells, and 7,121 dry holes. Industrial demands led to the drilling of 30% more gas-wells than in 1940. The rise in dry holes was 8%. Average drilling depths were 22 ft. greater than in 1940, although in the parts of the Eastern fields the additional output was obtained from shallower depths involving, however, the drilling of nearly 3000 water input wells. In coastal Louisiana the average increase in depth was 857 ft. To provide 1942 supplies requires the drilling of over 32,500 wells, but steel is unlikely to be sufficient for this number, which will lead to the over-production of reservoirs.

East of the Mississippi, except in Michigan, drilling increased in all the States. In Kansas many pools were linked on the Barton Arch and new areas were opened in the Anadarko basin. Most of Oklahoma's discoveries were only small fields. In North Louisiana there was intensive development of the Wilcox trend, and in Arkansas there was renewed activity in the Smackover lime producing area. Hawkins, in East Texas, gave rise to much wildcatting, which had little success, and there was a revival of drilling in the East Texas field. A campaign to extend the play westward in West Texas increased drilling by about 25%, and large producing areas have been blocked on both sides of the Pecos River. A number of small discoveries were made in North Texas, and the potentialities of the deeper pays became apparent in 1941. Gas developments increased in the Rocky Mountain area.

A summary is given of all wells completed in 1940 and 1941. G. D. H.

288.* Western Hemisphere Gains in Production Offset Other Losses. Anon. *Oil Gas J.*, 29.1.42, **40** (38), 87.—World production in 1941 is estimated at 2,209,761,000 brl., an increase of 3% over 1940, the increase being due to U.S.A.'s and Venezuela's rise of 95,298,000 brl. more than offsetting declines elsewhere. At the end of the year Venezuela's daily production of 750,000 brl. exceeded that of Russia, and if it is maintained in 1942 the total will exceed that of Russia by a considerable amount. Much of the increase was due to Oficina, San Joaquin, and El Roble. U.S.A.'s output rose by 4%. 60% of Mexico's production came from Poza Rica. In Canada there was a further extension of Turner Valley, where the production rose by 1,516,000 brl.

Russia's production slightly declined, and there are indications that Roumania's output was down by 20%. In Hungary the production rose by 75%, to exceed 10,000 brl./day at the end of 1941. Germany raised the oil ouput in Austria, Czechoslovakia, Poland, and France. There was a severe fall in Iraq's production, and the outputs of Iran, Saudi Arabia, and Bahrein also suffered.

The production in 1940 and 1941 is tabulated by countries. G. D. H.

289.* Texas Gulf Coast—Wilcox Trend and Jackson County Plays Yield Good Results. N. Williams. *Oil Gas J.*, 29.1.42, **40** (38), 111.—Twenty new fields, as well as new sands and extensions, were discovered on the Gulf Coast in 1941, in spite of a slight decline in drilling. Six new fields were found on the Wilcox trend, which appears extremely promising. For some time it had been thought that Wilcox production was limited to the zone between 6000 ft. up-dip and 9000 ft. down-dip, but early in 1941 oil was discovered 1100 ft. below the original Wilcox play, although prior to that many wells had been abandoned 500–600 ft. below the Wilcox section. At the end of the year there was prolific Wilcox production at 10,000–11,000 ft. In Jackson County there has been a Marginula-Frio play, leading to the discovery of Maurbro, followed by North La Ward. Ganado and West Ganado have proved to be important reserves

as a consequence of new sand discoveries. Other Frio sand strikes were at Oyster Bayou, Stowell, Chenango, and Lucky. Cockfield production was opened in the Garwood area.

Tables give the discoveries on the Gulf Coast during 1941, the monthly production of the major fields, the yearly output since 1936, and a summary of the wells completed in 1941. G. D. H.

290.* California—Northern San Joaquin Valley to Govern 1942 Prospecting. L. P. Stockman. *Oil Gas J.*, 29.1.42, **40** (38), 118.—For many years Californian prospectors have searched for new fields along well-defined lines of folding, either visible or revealed by the location and trend of producing fields, but the urgent need for maintaining crude and gas reserves will cause them to move into other areas.

The Panoche discovery well was completed in the Cretaceous at 7200–7277 ft., giving much gas and 150 brl. of condensate/day. Other Cretaceous wells in 1941 were unsuccessful, although, being intended initially to test the younger beds only, they were perhaps not very satisfactory Cretaceous tests. A number of commercial gas fields have been found in the Cretaceous in the central part of the State. The Raisin City field has opened up a considerable potentially productive area north of Coalinga, and fields have already been found at Helm and Riverdale.

The Cretaceous appears to have production possibilities which may later greatly affect California's reserves of crude oil and natural gas.

Ten oil-fields and one gas-field were discovered in 1941. Eight of the oil-fields and the gas-field were in the San Joaquin Valley.

Tables list the 1941 discoveries, the monthly production of the major fields, the annual production since 1936, and summarize the completions during 1941.

G. D. H.

291.* North Central Texas—Bend and Ellenburger Yield Best Discoveries of Year. D. H. Stormont. *Oil Gas J.*, 29.1.42, **40** (38), 125.—The majority of the many discoveries in North and West Central Texas were deeper pays in proven areas, but of the wells drilled, over half were less than 2500 ft. deep, and a quarter less than 1000 ft. There were nine Mississippian discoveries, six in the Ellenburger and twenty in the Bend, constituting over half the total. The K.M.A. Ellenburger production was extended to over 3000 acres, and was the greatest new oil reserve added in North Texas during 1941.

Thirty-one new pools or new producing horizons were opened in West Central Texas. Nearly all the new strikes were in the Cisco series, and many of them in Jones County. Deep tests to the Palo Pinto of the Canyon all failed. Two Strawn pools were added in Coleman County, and a deeper pay and two gas areas in Stephens County.

Tables show the North Texas production by fields and years for the period 1937–41, a summary of the wells completed in 1941, the 1941 discoveries, and the monthly production of the major fields in 1941. Similar data are presented for West Central Texas. G. D. H.

292.* North Louisiana, Arkansas, Mississippi—Central Louisiana Wilcox Sand Play Leads in Active Year. R. M. Sanford. *Oil Gas J.*, 29.1.42, **40** (38), 135.—There was extensive development of the Wilcox trend of fields throughout Central Louisiana, for there were ten new Wilcox sand discoveries in 1941. The wells are 100–200-brl. wells, often making some water.

In the old Haynesville field a new Pettit lime level was opened at 5431–5440 ft. Smackover lime distillate production was found at 10,148–10,398 ft. in the Lisbon area.

Two new gas-fields and an oil-field were discovered in the Smackover lime of Arkansas

An apparently major discovery and one of small importance were made in Mississippi. In addition, several new deep zones of production were penetrated in the Tinsley field. The Pickens-Sharpsburg discovery yields oil from the Eutaw. Tinsley now has seven separate producing zones, and has been extended in area.

The discoveries, monthly production of the major fields, annual production for the period 1937–41, and a summary of the well completions are given for North Louisiana, Arkansas, Mississippi, and the East Texas border. G. D. H.

293.* Illinois—Intense Wildcatting Yields Many New Fields and Additional Pays. Anon. *Oil Gas J.*, 29.1.42, **40** (38), 140.—The Illinois production of 128,630,909 brl. in 1941 was considerably below the 1940 figure, although more new productive areas and new pay horizons were found than in any other year. Most of the new pools in White County were small. The most prolific discovery was the Johnsonville pool of Wayne County, which yields oil from the McClosky mainly. The Aux Vases is also productive. Beds below the McClosky are untested, and the southern edge is still undefined. Woodland production is limited to the Benoist. The Tar Springs production at Benton is outstanding, and this has led to five additional Tar Springs discoveries in the basin. A Devonian test at Louden did not come up to expectations, but the formation's possibilities cannot be said to have been determined fully.

The Aux Vases sand seems to have been under-estimated, and many " dry " sands have now given much oil. It appears that the Dale and Hoodville pools will be linked through Aux Vases production. Levias production was found at Rural Hill, followed by Aux Vases and McClosky production.

The 1941 discoveries in Illinois are listed, together with the monthly production by fields, the annual production in the period 1937–41, and the 1941 completions. G. D. H.

294.* Louisiana Gulf Coast—New Fields and Flank Sands on Old Domes Share Interest. F. L. Singleton. *Oil Gas J.*, 29.1.42, **40** (38), 146.—Sixteen new fields were discovered in the Louisiana Gulf Coast area in 1941, at depths of 6700–10,990 ft., often with multiple sands. The most important fields seem to be Bayou Sale and St. Gabriel. The former is on a north–south structure, with production at 10,100–10,110 ft. and 10,310–10,342 ft. St. Gabriel has producing sands at 7700 ft. and 8880 ft.

Three fields were discovered in the Delta district, several sands being logged in the Miocene.

New sands were found on the supposed deep-seated salt structures of South Crowley, White Lake, Kenilworth, West Lake Verret, Erath, and West Bay. Exploration around many old salt domes fields opened important new production. A prolific Sparta producer was discovered on the east flank of the Pine Prairie dome at 8226–8233 ft. The early production was over the dome in the Miocene and in the cap-rock at depths of 1300–3200 ft., but was short-lived. Distillate production was found at 9830–9870 ft. on Belle Isle.

Production data are given by years for the period 1937–41, and by months for 1940, and the 1941 discoveries are listed, together with a summary of the 1941 well completion. G. D. H.

295.* South-west Texas—Oil-Sands Flanking Gas-Distillate Fields have Large Reserves. F. L. Singleton. *Oil Gas J.*, 29.1.42, **40** (38), 153.—In 1941 important crude production continued to be found from down-structure sands flanking the huge gas-distillate structure of the Agua Dulce–Stratton field. All production was from sand lenses at 5500–7200 ft., which can usually be correlated with the gas-distillate sands of the gas-cap. The structure runs north-east–south-west for 16–18 ml. and is about 5 ml. wide. The La Gloria and La Reforma gas-distillate fields were also converted into oil-fields by flank development. Crude was found in new sands in the Odem gas-distillate field. New sand discoveries were made at Midway and Luby. Wilcox production was obtained in Quintana 1-B Washburn. A new discovery and several extensions were made along the lower Frio-Vicksburg trend in Starr County, and shallow fields were opened in the Laredo district

Tables give the 1941 discoveries, the monthly production of the major fields in 1941, and the annual production in the period 1937–41, as well as a summary of the completions. G. D. H.

296.* Eastern Texas—Drilling Localised in Hawkins and East Texas Fields. D. H. Stormont. *Oil Gas J.*, 29.1.42, **40** (38), 161.—The Hawkins field, discovered late in

1940, has proved the area's most important discovery for many years, and was the scene of much activity in 1941. Two new Woodbine oil-fields were found, and one with a pay in the Rodessa of the lower Glen Rose. Oil production was opened in the Pettit lime and Rodessa in the Willow Springs gas-condensate area, and a small oil-producer was drilled in the Pettit in the Groesbeck gas area.

The Pleasant Grove structure is erratically faulted, thereby slowing development, and the East Long Lake field seems to be on a separate structure from Long Lake, 2 ml. to the south-west.

The annual production by fields for the period 1937–41, the discoveries, the monthly production of the major fields in 1941 and a summary of the well completions are given. G. D. H.

297.* Kansas—Three Regional Plays Added to Barton Arch Development. R. Ingram. *Oil Gas J.*, 29.1.42, **40** (38), 164.—Intensive development of pools along the Barton Arch led to the joining of many of them into large producing areas. The Patterson pool was opened in a stray Pennsylvanian sand at 4740–4782 ft., and its significance is its location well away from previous production, in the Dodge City basin. In Jefferson and Leevenworth Counties oil found near McLouth led to the drilling of thirty-three wells during 1941. The Zenith pool in Western Kansas is a stratigraphic Viola lime-trap with oil also in the overlying Misener. Efforts to locate an extension of the shore-line apparently succeeded in the discovery of Peace Creek to the north-east.

Tables show the 1941 discoveries, the monthly production of the major fields, the annual production in the period 1937–41, and a summary of the wells drilled in 1941. G. D. H.

298.* Canada—North Turner Valley Raises Candian Production Record. V. Lauriston. *Oil Gas J.*, 29.1.42, **40** (38), 172.—In 1941 Canada's oil production was 10,107,000 brl., chiefly from Alberta. A large producer may indicate a possible extension of Turner Valley to the south-west, but in the north two dry holes appear further to define the limits, although there was considerable northerly extension of the producing area. The Steveville-Princess field, 110 ml. east of Calgary, gave 19,337 brl. of crude in 1941, and while several wells were unsuccessful, late in the year a 100-brl. well was completed at 3190 ft. A large area of production at 1800–1900 ft. has been proved at Vermilion. A number of wildcats were drilled with little success, but the one on the Twin River structure yielded 30–50 brl./day from the Madison at 3969 ft.

There was an active drilling campaign for gas in Ontario.

The gas and oil production of the various areas are tabulated. G. D. H.

299.* Wildcatters Find Many Small Pools in Indiana. Anon. *Oil Gas J.*, 29.1.42, **40** (38), 172.—In 1941 some of the best pools were discovered since the opening of the Griffin pool, although most of the finds were small. The activity was chiefly in the Griffin pool. The Heusler and Bufkin pools, producing from Chester sands, were extended. G. D. H.

300.* Permian Basin, Panhandle—Deep Pays and New Fields in North will Keep Basin Active. D. H. Stormont. *Oil Gas J.*, 29.1.42, **40** (38), 173.—In 1941 in the North Basin outside proven areas activity was directed towards extending the productive limits northward and eastward from Slaughter, the most northerly pool. Most of the wildcatting aimed at the San Andres and Clear Fork pays. In the south basin much of the wildcatting was associated with the trend of Lower Ordovician pools in Crane and north-eastern Pecos Counties. Thirteen new fields or possible major extensions were opened, and there were altogether twenty-seven new discoveries.

A deep-seated structural trend has been established on the platform between the two trends of Permian production on the rims of the platform. Simpson and Ellenburger production has been obtained. 20 ml. south-east of Big Lake Ellenburger production has been found at a depth of 9200 ft. The structure is apparently of large extent. Oil was obtained in the Strawn crinoidal lime 3½ ml. west of the Todd deep field in Crockett County.

Five miles east of Lubbock in the north oil was obtained in the Clear Fork lime, stratigraphically lower than the San Andres, which is productive at Wasson, Slaughter, and Cedar Lake. 2000 ft. below the regular pay oil has been found at Wasson.

The 1941 discoveries are listed, together with the monthly production of the major fields, the annual production during the period 1937–41, and a summary of the well completions in 1941. G. D. H.

301.* Rocky Mountain Area—Gas Development in all Areas Shows Large Increase. T. R. Ingram, *Oil Gas J.*, 29.1.42, **40** (38) 178.—The most important discovery in Colorado in 1941 was the finding of Sundance production at Wilson Creek. Gas was found in the Wasatch on the West Hiawatha structure in exploring sands which yield oil on the East Hiawatha structure. An extension was made to the Powder Wash oil- and gas-field by the completion of a large gas-well. Along the same line of folding gas was discovered on the Canyon Creek structure in Wyoming. This was also in the Wasatch, and the well had an oil showing 650 ft. above the gas-sand. A gas-well was completed in the Dakota in South Elk Basin. Extensions were made to the Wertz and Cole Creek fields.

In Montana oil was discovered west of Kevin-Sunburst. A gas discovery with favourable oil indications was made on the Twin Rivers or Reagan structure. Between the Kevin-Sunburst and Cutbank fields, and also 25 ml. east of Kevin-Sunburst, gas in quantity was found.

The Farmington sand has given oil in the Fulcher Basin district where the Picture Cliff sand yields gas. The Clay Basin gas-field of Utah now covers an area 4 ml. long and 1½ ml. wide.

Tables give the Rocky Mountain discoveries in 1941, the annual production since 1936, the monthly production of the major fields in 1941, and a summary of the wells completed. G. D. H.

302.* Michigan—New Fields in Northern Sector Reverse Production decline. O. Pressprich. *Oil Gas J.*, 29.1.42, **40** (38), 182.—During the first half of 1941 Michigan's oil production was slowly falling, but in June deepening of a small well to test the Dundee and Monroe at Reed City opened up a field in which both the Monroe and Traverse have proved prolific. The Headquarters field yields Traverse oil. A gas-pay was located in the Monitor area of Bay County, and Berea oil has been developed.

The annual production for the period 1937–41 is tabulated, as well as the monthly production of the major fields in 1941 and a summary of the well completions. G. D. H.

303.* Oklahoma—Anadarko Basin Play Starts; Old Areas Reworked. R. Ingram. *Oil Gas J.*, 29.1.42, **40** (38), 183.—During 1941 there was much reworking of old producing fields which failed materially to affect reserves in spite of many discoveries. In the south-west excellent production was found in Simpson sands at Apache and Velma. Some of the eight Apache wells have potentials as high as 15,000 brl./day. In the older areas, Guthrie, Tecumseh Lake, Hotulke, and West Hotulke are the outstanding new pools, although they do not appear to be of the Apache ranking. In addition to drilling on small structures, secondary recovery methods were introduced to maintain production.

The 1941 discoveries and extensions, monthly production of the major fields during 1941, the annual production during the 1937–41 period, and a summary of 1941 well completions are tabulated. G. D. H.

304.* U.S. Crude Reserves Rise. Anon. *Oil Wkly*, 26.1.42, **104** (5), 48.—In spite of the production of a record quantity of oil, the amount discovered but unproduced rose to a new peak during 1941. An estimated 1,903,344,000 brl. of new oil were discovered against production of 1,403,784,000 brl., and on 1st Jan. 1942, the crude oil reserves were estimated at 19,524,075,000 brl. Nevertheless, the additions to reserves were the smallest since 1935. The amount of oil found per dry hole fell by 11,354 brl. to 266,313 brl., again the lowest since 1935.

Most of the increase in crude reserves in 1941 was in the south-western group of States, where Texas was the chief gainer with 1,007,750,000 brl. Louisiana, Arkansas, and Illinois increased their reserves, whereas California, Oklahoma, and Kansas failed to find as much oil as they produced.

Tables give the crude reserves by States at the beginning of each of the past six years, the oil discovered, that produced, the excess and accumulated reserves, as well as the number of dry holes for various years or periods; some details of the 1941 oil discovery rates. G. D. H.

305.* **Many Fields Found.** Anon. *Oil Wkly*, 26.1.42, **104** (8), 65.—During 1941 the greatest number both of new fields and new horizons in old fields ever attained in a year were discovered in U.S.A. There were 346 new fields and 267 new horizons, considerably more than in 1940. The trend in discoveries has been almost continuously upwards during the past five years. The average depth of the 613 discovery wells in 1941 was 4355 ft., as compared with 3444 ft. in 1940 and 4253 ft. in 1939. The numbers of new fields, new zones, and the average depths of discoveries are tabulated by States for the years 1936–41. Other tables list by States the names, locations, discovery date, producing formation, depth, initial production and oil gravity of all the 1941 discoveries. G. D. H.

306.* **Production by Fields.** Anon. *Oil Wkly*, 26.1.42, **104** (8), 75.—During 1942 three more American fields are due to qualify as "100,000,000 brl." fields, a state achieved by only forty-two fields so far. The three fields are Chalk, Big Lake, and Hobbs. East Texas has produced 1,702,847,000 brl. of oil.

The fields which have given over 100,000,000 brl. of oil each are listed, and further tables give by States the discovery year, production in 1940 and 1941 and cumulative production of the various fields in U.S.A. G. D. H.

307.* **Wells Completed.** Anon. *Oil Wkly*, 26.1.42, **104** (8), 101.—32,265 wells were completed in U.S.A. in 1941, not many fewer than in the record year of 1937. There were 20,113 oil-wells, including wells drilled deeper. 2656 gas-wells were drilled, and there were 7147 dry holes. 2184 water-intake wells were drilled, in addition to 117 gas-input wells and 48 salt-water-disposal wells.

Gas demand led to a rise of 60% in Ohio's completions, and there was a 22% rise in West Virginia. The rise in completions in Texas was 9%, while Michigan had a fall of 25% in the 1941 completions.

Tables show the number of wells completed, the types, total initial production, and average per well for the period 1859–1922 and by years from 1923 onwards; the total completions, types, and initial outputs by States for 1940 and 1941, with the same data broken up according to fields and states for 1941. G. D. H.

Drilling.

308.* **Record Number of Deep Tests Drilled During 1941.** H. F. Simons. *Oil Gas J.*, 29.1.42, **40** (38), 193.—A statistical review of deep-well drilling for 1941 is presented dealing solely with U.S.A. activities. A. H. N.

309.* **Use of Hard-facing Material on Rotary Tool Joints.** T. P. Sanders. *Oil Gas J.*, 5.2.42, **40** (39), 36.—Acceptance of tool-joint hard-facing in California has been accelerated by results made public from comprehensive tests conducted by a major West Coast oil company. These tests were carried out in the Ventura field, where drill-pipe wear is as severe as in any field west of the Rockies. The tool-joints were calipered after each run, and extensive tests showed that joints hard-faced with the electric-tube tungsten-carbide rod lasted two and a half to three times as long as the unfaced joints. Calculating that a saving of $50/joint could be made with hard-facing, the company standardized on the tungsten-carbide rod, and laid down a definite procedure for its use, which is described. The process is used for hard-facing new, re-sleeved, or slightly worn joints. A discussion of face-hardening is given.

A few general rules apply to the hard-facing of all types of tool-joints: (1) Before the hard-facing is applied, the joint should be preheated to a temperature of approximately 300° F. to take the chill out of the steel. (2) It is good practice to weld the joints to the pipe with mild steel electrodes before applying the hard-facing. (3) A copper form should be used to help obtain a square elevator shoulder, but this cannot be done when the tungsten-carbide electrode is used. (4) In running a bead around a tool-joint lying in a horizontal position on a pipe-rack, a smoother application of hard-facing can be obtained if the welder works from the top of the joint down, rather than from the side nearest him towards the top. With the molten metal running downwards behind the electrode as the welding progresses, ridges or waves in the hard-facing are largely avoided and there is far less likelihood that the finished facing will be out of round. This recommended procedure also makes it natural for the welder to "drag" the electrode over the surface rather than push it, and this technique makes for faster progress. (5) It is unnecessary to hard-face both the pin and the box of a joint. On integral-joint drill-pipe the pins should be hard-faced, but the boxes of all other types of tool-joints should receive the application. Where the tool-joints are the type attached by the flash-welding process, the boxes are built up in a manner similar to that set out for worn joints except that the welding of the joint to the pipe with a mild steel electrode is unnecessary. (6) When self-hardening alloy is being applied, 25–50% more amperage should be used than is customary with the coated mild-steel rod. The additional heat is necessary for proper fusion of the alloying metals.

When new joints are to be hard-faced the work is carried out before the string is sent to the field. Each of the elevator shoulders is recessed ¼ in. deep in a band 1 in. wide, and the hard metal is deposited in this recess. This is done so that an application of sufficient thickness can be made without resulting in over-sized joints. These applications are to be avoided because they have a tendency to become undercut, thereby serving to nullify the effectiveness of the hard metal. A. H. N.

310.* Reduction of Hole Size in Drilling as Affecting Costs, Completion, and Production Practice. Part I. I. W. Alcorn and J. U. Teague. *Oil Wkly*, 2.2.42, **104** (9), 15. *Paper Presented before American Petroleum Institute.*—This paper represents a joint effort of the south-western District Topical Committees on Drilling and Production Practice. The data submitted on some 2300 wells from all sections of the country indicate a trend towards the drilling of smaller-diameter holes, both exploratory and proven, and completing wells with smaller casing. Substantial savings are being effected in initial well costs by this practice.

No particular difficulty has been reported in drilling, completing, or producing the small-diameter wells. Nearly all the fields on which data were obtained are in the flowing stage; consequently little information is available on artificial-lift installation in the small-diameter wells. But the predictions are that no trouble will be experienced with artificial-lift equipment in the small-diameter wells, except when a large volume of fluid has to be produced with rod-pumps.

Small-diameter wells can be repaired by all commonly used methods as easily and cheaply as those of large diameter except when the well is to be deepened or sidetracked, in which case the small-diameter well is at a disadvantage. The majority of the small-diameter wells were completed with 5½-in. OD casing, which is considered by the majority of those who submitted data to be the smallest practical casing size to use. The popular size hole to drill for setting 5½-in. OD casing seems to be 8¾-in. A 9⅞-in. hole was drilled for most of the large-diameter wells reported, and 7-in. OD casing was set as the final casing string.

The trend towards the drilling of smaller holes and setting smaller casing will probably continue, because of the lower initial well cost, long expected flowing life of most fields, and the low rates of production on individual wells under enforced curtailment of production.

The paper is well illustrated with tables and diagrams and references are appended. A. H. N.

311.* Drilling Rig Designed for Ready Portability. W. A. Sawdon. *Petrol. Engr*, January 1942, **13** (4), 38.—The rig equipment consists of two main units mounted on semi-trailers and hauled by a semi-trailer tractor unit, all units being of road width and meeting legal requirements for load. All movement is made on pneumatic rubber-

tyred wheels. Of particular interest is the arrangement of the equipment when rigged up for drilling operations.

The drilling and pumping units are mounted permanently on the semi-trailers, which have three axles in the rear. During transportation the front of the semi-trailer is supported on the tractor unit, which hauls one unit to a new location and then returns for the other. Incidentally, the tractor also hauls a light semi-trailer used for general lease work while the other units are drilling.

One main unit consists of the hoist, its engine, the folding derrick, and auxiliary equipment used with these items. The other consists of two mud-pumps and their two engines, complete with manifold, large double tool-box, and lighting unit. The two units are mounted side by side with a walkway between. Before they are moved into place guide-tracks are laid at the location and the semi-trailers carrying the units are backed into position on these tracks. This provides for the alignment of the units in the desired position so that connections between the two units can be made rapidly and with minimum work. All water, mud, fuel, and electrical connections are built into the units. The forward ends of the trailers when rigged up are the ends away from the derrick floor and rest on tubular steel supports. Jacks placed near the wheels that are adjacent to the derrick floor relieve the load on the rubber tyres.

Each main part of the rig is described separately, giving capacities and other specifications. A. H. N.

312.* New Drilling Rig Embodies many Valuable Features. H. L. Flood. *Petrol. Engr*, January 1942, **13** (4), 42.—Many unusual features have been incorporated into the design and assembly of the drilling equipment, among the more important of which are :

1. The 122-ft. mast or derrick, by far the highest mast yet designed to be erected as a unit.

2. The all-wheel-drive truck-chassis supporting the drilling engines, draw-works, rotary table, etc. Noteworthy is the absence of a conventional truck engine ; motive power for the truck when changing locations is supplied by the drilling engines.

3. The trailer that serves as a permanent base for the two 7½ by 12 mud-pumps. The fuel-tank and light-plant are also mounted on the trailer.

4. The compact design of the flanking substructure, walkways, and pipe-rack, representing virtually the only accessory equipment (other than the tool house) not permanently mounted on mobile equipment.

When on the road, or when making a move from one location to another within a given field, the " caravan " of trucks transporting the drilling equipment will comprise the following units : (1) The main truck, on which the engines, draw-works, table, bottom section of mast, etc., are mounted. (2) The pump trailer pulled by a medium- or large-sized oil-field truck. The trailer also carries the middle mast section during a move. (3) An oil-field truck on which the upper section of the mast is loaded, together with the substructure. (4) An oil-field truck on which the tool-house and pipe-rack are loaded.

Depending on the distance of the move, another truck or trucks may be used to haul the drill-pipe. Otherwise, on a short move, one of the above trucks may " shuttle " back and forth, making several trips to haul the various accessory equipment.

Although it was possible to describe only one operation at a time, it should be borne in mind that many of the operations involved in rigging-up proceed simultaneously. In this way the total time required to move and rig-up is reduced to a matter of hours.

Main items of the rig are described, and it is pointed out that it is found extremely easy for new crews to adapt themselves to the new rig. A. H. N.

313. Patents on Drilling. E. O. Roemhild. U.S.P. 2,270,604, 20.1.42. Appl. 23.6.39. Driving coupling for pipes forming hollow piling sections of different diameters.

W. L. Church. U.S.P. 2,270,647, 20.1.42. Appl. 15.6.39. Casing-plug for cementing the perforations in a well casing.

W. L. Church. U.S.P. 2,270,648, 20.1.42. Appl. 16.2.40. Cementing-plug having a packer arrangement.

P. H. Jones. U.S.P.2, 271,695, 3.2.42. Appl. 14.1.38. Conditioned well-drilling fluid having low gas-cutting tendencies and a fatty acid constituent.

P. H. Jones. U.S.P. 2,271,696, 3.2.42. Appl. 24.1.39. Conditioned well-drilling fluid having an ester of a fatty acid as a constituent.

O. J. McCullough. U.S.P. 2,271,742, 3.2.42. Appl. 18.8.39. Cable-measuring device, the cable being wound on a drum.

A. Hossfeld. U.S.P. 2,272,087, 3.2.42. Appl. 7.6.40. Drilling machine using a reciprocating hollow shaft at the end of which there is a bit, the shaft being simultaneously rotated. A. H. N.

Production.

314.* Reserve Estimates Provide Important Danger Signals. W. V. Howard. *Oil Gas J.*, 1.1.42, **40** (34), 18.—The estimate of reserves as of a certain date, if presented alone, has very little significance. However, figures, say in terms of years' supply, for two dates do indicate tendencies. The complete definition of some fields is an extremely slow process, and improvements in technique may greatly increase recoverable reserves. Thus, prior to flooding, Bradford gave 203,000,000 brl. Flooding has given 186,250000 brl., and it is estimated that 178,397,000 brl. remain to be produced.

There is a definite reason for allocating oil reserves to the year of discovery of the field, and even of including lower sands, for a pool, once discovered, is unlikely to be abandoned until prospected to the limit, and hence all oil to be found in that field throughout its whole future history has become a routine development so far as prospecting is concerned.

Investments are not made on the basis of only 15 years' supply, especially when it is realized that some of that oil will still be in the ground 50 years hence, but on the basis of continued replenishment of reserves, so that oil may be produced at the current rate, or even at an increased rate, for many years.

It seems desirable to prepare estimates of reserves by the inventory method and by allocation to the year of discovery. When the two estimates approach each other, more exploration is needed to maintain the future position, and when the inventory method shows a decline below a certain level in years' supply of available oil, this also is a danger signal. G. D. H.

315.* Increase in Oil Production by Application of Chemicals. P. E. Fitzgerald. *Oil Gas J.*, 29.1.42, **40** (38) 194.—A brief summary of different types of chemicals used to increase production is given. Inhibitors to prevent acid corrosion have been an important adjunct in well treatment, and are even more so now that well equipment is difficult to replace. Surface-tension reducing agents have been used for several years to facilitate uniform penetration of the acid into the formation and to assure easier, more complete and rapid removal of the spent-acid products. These agents have a definite application in formations of either low permeability, low pressure, or both.

Agents capable of changing rates of reaction of acids on different types of formations are available. Some of these increase the rate of reaction on dolomitic and siliceous formations, whilst others tend to reduce the reaction rate on fast reacting formations. The latter agents permit greater penetration of the acid before it becomes spent—an important factor in old wells where it is desirable to secure maximum penetration of the formation.

A large number of demulsifying compounds is available for use in wells where the acid or spent acid may form serious emulsions. The type of demulsifying agent used will depend on the type of oil and the emulsion formed as a result of the treatment. Blankets and organic gel compounds to prohibit or minimize the downward movement of the treating compounds into water or an otherwise undesirable portion of the exposed formation are available. All these are for temporary use, and can be removed by normal production methods, no special clean-out operations being required.

There are also chemically inert, fragmented, flakey substances that are useful in preventing mud losses in drilling walls, regaining circulation losses in drilling and

cementing operations. They also lend greater plugging properties to the organic gels used in temporary plugback operations and selective acidizing techniques.

Other chemicals often used are paraffin solvents of many types, gyp or scale solvents, and special acid compounds for the dispersion and disintegration of mud sheaths, infiltered water, and similar deposits that may be causing a reduction of the flow of fluid through the critical area surrounding the well and the screen. The latter group includes the "mud acids" which have been especially beneficial in wells on the Gulf Coast of Texas and Louisiana.

More recently "formation cleaner" treatments have been found to be quite successful in certain types of wells where hydrocarbon deposits are thought to be causing production difficulties. The chemicals used in these treatments do not depend on an acid reaction, and are therefore applicable to all types of formations.

Another group of chemicals that have an interesting application in some types of wells is certain inorganic gels and special resins used for shutting off water and other undesirable fluids, to lower gas–oil ratios, water–oil ratios, and to save casing in some cable-tool drilling wells.

The methods adopted for injecting the chemicals are briefly reviewed.

A. H. N.

316.* New Liner-Cleaning Method Fills Need. T. P. Sanders. *Oil Gas J.*, 29.1.42, **40** (38), 206–207.—A new liner-cleaning method is reported. A string of fuse-like explosive was hung through the liner of an old California well that had ceased to produce. After it had been detonated and many barrels of silt had been bailed out of the liner, the well was put on production at the rate of about 200 brls./day, of which only 10% was water.

The explosive fuse, known to its users as the "cleaner," closely resembles the Cordeau–Bickford fuse long used in mining operations. It differs mainly in that it does not carry a lead-jacket and its explosive core is smaller. Being flexible, it is easily handled, and can be run over small pulleys at the well-head. Its tensile strength permits hanging a weight at the bottom so that the "cleaner" can be lowered to the desired position under fluid in the liner. The fuse diameter is slightly less than the thickness of a lead pencil.

A detonator is installed at the top of the explosive fuse where the connection is made with the shooter's line. This is a rather small cap, which is detonated by electricity from a switch at the surface. The detonator must be specially designed and manufactured to guard against premature discharge due to fluid pressures.

Experimentation was necessary to formulate general rules for the correct loading of wells. In most wells equipped with 5¼- to 6½-in. liners, two strings of explosive fuse are detonated simultaneously side by side. In older wells, where liners are likely to be weak from corrosion, only one string of "cleaner" is used, in order to avoid any possibility of splitting the liner. Other conditions influencing determination of the proper number of "cleaner" strings to use include: (1) size of slots or perforations; (2) number of slots or perforations/unit of area, and (3) whether the liner is made of welded or seamless pipe.

Recommendations are given for the proper use of the method. A. H. N.

317.* Gas Jetting Used to Lift Oil at Aransas Pass Field. N. Williams. *Oil Gas J.*, 5.2.42. **40** (39), 33–34.—The development and present conditions of the field are reviewed. The first stage of production is now over. Recovery of the remaining production by artificial methods presents various problems. Conditions in this field have not been regarded as suitable for conventional pumping. Not only are the main sands below 7000 ft. in depth, but wells have comparatively low fluid levels, and with increasing volumes of water to be lifted, costs of pumping might become prohibitive. This has led to consideration of other means of lifting the oil.

Plans of operators now call for the recovery of remaining production by gas-jetting, and within the past year this practice has been undertaken on a rather extensive scale in this field. By jetting, premature abandonment of many wells is being forestalled and increased recoveries made possible. Lack of adequate available gas supplies and pressures in the field for prolonged jetting operations presents a problem, but operators

generally are looking to the possibility of being able to lay a pipe-line to some nearby high-pressure gas-field by the time additional gas volumes are needed to carry on operations. Two corporations are now undertaking the jetting, and some details are given. A. H. N.

318.* World Production Outlook. Anon. *Oil Wkly*, 26.1.42, **104** (8), 40.—War has accelerated oil production in Venezuela and Canada, but in many other countries loss of markets and transport, and difficulties in obtaining drilling equipment, have had an adverse effect. Thus Mexico's output in 1941 fell 20% below the 44,000,000 brl. of 1940. Turner Valley in Canada gave over 95% of the country's output of almost 10,000,000 brl. of crude, which was about 9% above 1940. Venezuela gave 223,000,000 brl. compared with 185,000,000 brl. in 1940. Colombia's output fell 7% in 1941 to 24,313,000 brl., due to a lack of tankers and failure to develop new fields. Argentina produced 21,639,000 brl. of oil in 1941, 70% of the output being from Comodoro Rivadavia. The Iranian production may have declined slightly in 1941, and that of Iraq has fallen seriously, due to loss of markets. The production of the Netherlands East Indies was probably unchanged at about 62,000,000 brl. It appears likely that Roumania's production fell to 36,000,000 brl. in 1941, as compared with 43,000,000 brl. in 1940. G. D. H.

319.* U.S. Production Up. Anon. *Oil Wkly*, 26.1.42, **104** (8), 61.—In 1941 U.S.A. produced 1,403,784,000 brl. of oil, 30,000,000 brl. more than in 1940. Kansas had the largest increase, with 17,000,000 brl. and a total of 83,045,000 brl., and Texas (total 507,391,000 brl.), Louisiana, Mississippi, and California had increases of fourteen million, thirteen million, eleven million, and seven million barrels respectively.

A table shows the production by states and years from 1859 to 1941. G. D. H.

320.* Drilling Cost Reductions Permit Deeper Flooding. F. B. Taylor. *Oil Wkly*, 2.2.42, **104** (9), 13–14.—From a strictly engineering viewpoint there appears little question but that deeper horizons can be flooded successfully. The fundamental question is not so much one of engineering as of economics. Floods at depths exceeding 2000 ft. have at times been condemned, on the basis that costs would be prohibitive under nearly any probable economic condition. This is not necessarily true. There are many variables in development costs, some of which allow reduction with depth, and others do not increase in proportion to footage below the surface if more economic practices are adopted.

Drilling expense, the most important budget item, would naturally increase with depth, but could be reduced through adoption of wider well spacing and certain practices that would curtail expenses. The complete water system, second major budget expense is relatively constant regardless of depth. The third function of importance is producing equipment, which cannot be varied too extensively on deeper projects, although some possibilities exist.

Consequently, in attempting to reduce operating costs on deep water-floods, expenditure reductions must be made all along the line, but primarily in connection with drilling expense.

Analysis is made of the effect of drilling and lifting expense on flooding operations. The results are presented in a concise tabular form. A. H. N.

321.* Reducing the Quantity of Salt Water Produced with Oil. F. J. Mikeska. *Petrol. Engr.*, January 1942, **13** (4), 23–26.—Of the various methods employed in an effort to reduce the volume of salt water lifted with the oil production, that which has proved effective in many respects has been the use of a subsurface choke in the tubing string below the pump or gas-lift equipment. This method is discussed.

As implied, the use of a subsurface choke has usually been restricted to pumping or gas-lift wells, the number of which is increasing in the field, as more wells cease flowing from year to year. The generally accepted conception of water encroachment by coning pictures a more or less well-defined plane or surface of contact existing initially between the oil-body and the underlying water. When a well is drilled and completed

in the oil-saturated section, presumably a reasonable distance above the water-bearing stratum, and the well begins producing, the reservoir system changes immediately from a condition of static equilibrium. As flow is established and fluid enters the well-bore, lines of flow are established throughout that portion of the reservoir " controlled " by the well. When only one well serves as an outlet for the reservoir fluid, all lines of flow are directed to this one means of outlet. When two wells are producing from the reservoir, the division of flow-control between the wells is determined basically by the relative volumes produced from the two wells. As the number of wells producing from a common reservoir increases, the number of flow patterns likewise increases. If the rate of withdrawal is restricted, there is less pressure drop and the oil moves laterally along horizontal flow lines to a greater extent than water moving vertically upward.

The function of subsurface chokes is controlling the flow of salt water. Performance data are presented. Based on the results obtained thus far by employing subsurface chokes to control water production, the method appears to have considerable merit. Although there may be conditions in individual wells that might preclude the successful use of a choke, it is believed that application of the method at least should be given consideration by every operator confronted with the problem of producing wells in East Texas by artificial lifting methods. A. H. N

322.* **Petroleum Engineering.** Part 1. L. C. Uren. *Petrol. Engr*, January 1942, 13 (4), 27–30.—In this, an informal paper, Professor Uren describes the requirements in training petroleum engineers. Problems encountered in this work are presented. Common problems include those incidental to oil-field development, such as construction of roads, power, water supply and communication facilities and construction of camp buildings; planning and analyzing development programmes, including decisions relative to spacing, arrangement and time and order of drilling wells; the operations incidental to drilling, including transportation and erection of drilling rigs and closely related operations of installing casing and excluding water from wells; methods of well completion, installation of production equipment, and estimating productive capacity.

The production phase of the industry includes studies of subsurface reservoir conditions that govern the production of oil and gas; the installation, testing, and operation of well-pumping equipment, operation and control of flowing and gas-lift wells, well maintenance and repair work, and conditioning of wells to obtain maximum production efficiency. Related to the production phase is the care and handling of oil and gas after they are brought to the surface; gas-trapping, dehydration of oil, pipeline gathering, and transmission of gas and oil; gauging, sampling, and testing of oil and gas. Special so-called " secondary " methods of oil recovery designed to improve production efficiency and obtain an additional " crop " of oil after ordinary methods based on utilization of natural expulsive forces have failed, require close engineering supervision.

A special province of the petroleum engineer is that of maintaining well and property records, such as well logs and other subsurface data obtained during the drilling process. Property and well surveys and maps, records of production, cost data, materials and equipment records and tests are commonly entrusted to engineering personnel. Special phases of this work involve the making of well surveys, electrical logs, depth-pressure surveys, depth-sampling of fluids, inspection and testing of formation samples and oil, gas, and water obtained from different strata. Still more advanced aspects of the work of the petroleum engineer include property management, appraisal of producing properties, and work involved in proration and other methods of production control.
A. H. N.

323.* **Subsurface Flow in Condensate Sands.** J. Breaker. *Petrol. Engr*, January 1942, 13 (4), 80. *Paper Presented before Petroleum Industries Association, Texas.*—Condensate field principles are summarized. The events following upon a drop of pressure in condensate fields are discussed. The only efficient means of operating a condensate recovery system is to maintain the reservoir at as near the original pressure as possible by the injection of the dry residue gas into the same formation from which it was taken. This cycling process, as it is accurately termed, serves four important purposes: (1) it prevents the formation and subsequent loss of condensate in the reservoir; (2) it

drives nearly all the wet gas to the producing wells; (3) it enables greater production rates from the wells, by keeping an almost constant high pressure on the sand, and (4) it conserves the dry residue gas to be later sold as fuel.

Diffusion effects are reviewed. It seems certain that there will be dilution when there is a permeable streak in the sand, particularly when it is between the input and the production well. The velocity of the gas will be greater through the more permeable area, and will cause a fingering of the dry gas into the wet gas area. This will take place to a greater extent when the wells are handling more gas.

Well pattern and spacing for injection and output wells are discussed, together with completion methods used. Well-control is studied at the end. In one instance, where an area of high permeability was known to be present between an injection and a supply well, the problem was solved by injecting a quantity of clear water into the injection well. The water will seek the area of greatest permeability and stay there, preventing the gas from by-passing through it.

An important phase of well control is testing. Tests should be made regularly and frequently. In this way reservoir conditions can often be determined and serious trouble sometimes prevented. It is helpful to plot results of tests in order to observe the trend of the well. All these tests need not be complicated. Before a well begins drying up, some idea as to its comparative content can be had by merely finding the end-point of the condensate. This will not necessarily be true after dry gas reaches the well, the encroachment of which may increase the bottom-hole pressure and vaporize around the well-bore. A. H. N.

324. Patents on Production. A. Arutunoff. U.S.P. 2,270,666, 20.1.42. Appl. 4.11.37. Deep well pump of the centrifugal type.

E. L. Barker. U.S.P. 2,271,535, 3.2.42. Appl. 3.8.40. Well flowing device with an automatic cut-off valve responsive to fluid velocity in a pipe in the well-head.

K. H. Kanalz. U.S.P. 2,271,594, 3.2.42. Appl. 9.10.39. Pumping mechanism comprising a pair of walking beams projecting in opposite directions from each other and worked simultaneously by one motor.

F. R. Shultz.—U.S.P. 2,271,832, 3.2.42. Appl. 13.5.40. Gas and water separator for wells and the like.

H. U. Garrett. U.S.P. 2,271,859, 3.2.42. Appl. 5.12.38. Two stage intermitter mechanism for use in wells working on gas-lift.

H. Y. Carson. U.S.P. 2,271,936, 3.2.42. Appl. 9.12.40. Pipe joint for bell and sprigot pipe.

F. E. Roberts. U.S.P. 2,272,022, 3.2.42. Appl. 17.11.39. Tubing head with a combination guide and seal for pump rods wherein the rod is subjected to flexing action. A. H. N.

Transport and Storage.

325.* Vapour-Saving Roofs for Gasoline Tanks Found Profitable at Bettendorf. Anon. *Nat. Petrol. News*, 15.11.41, **33** (45), 19–20.—The different types of roofs are described. *Breather-Roof.*—A flexible steel diaphragm, attached at periphery to tank and supported but not fixed to a framework when in "down" position. Recommended for tanks more than 60 ft. in diameter, and with a small throughput. Prevents breathing losses when tank three-quarters to full and reduces loss when contents are lower. *Balloon-Roof.*—An extension of the breather-roof idea providing larger capacity for vapour accommodation. Roof usually 12 ft. larger in diameter than tank. Said to be more efficient than breather-roof for smaller tanks and to prevent breathing loss from nearly empty tanks. May affect partial reduction in filling losses. *Floating Roof.*—A pontoon deck rests directly on liquid surface and prevents all vapour loss by preventing vapour formation. *Spheroid Tanks.*—Designed to withstand maximum vapour space

pressures resulting from normal temperature changes and vents set to operate only under extreme conditions. Breathing losses in storage exceed losses during filling which are harder to reduce. The annual breathing loss from 2,000,000-gallon tank with ordinary roof may amount to 2·6% and filling losses to 0·2% per fill, a total of 80,000 gallons for 6 fills per annum. Vapour saving roofs may reduce the loss to 20,000 gallons. It is suggested that the installation cost may be recovered in gasoline saved in 2 years. H. G.

326.* Southern Pipe-Line Undertakes Cathodic Protection in Saxet. N. Williams. *Oil Gas J.*, 4.12.41, **40** (30), 38.—In Saxetfield, Lower Texas Gulf Coast, a heavy black clay, highly alkaline, soggy, poorly drained soil has been unusually conducive to electrolytic corrosion. Coating of lines has not afforded sufficient protection and cathodic protection is being undertaken. Lines involved form a complicated network and are of great variety, representing both high and low pressure gathering and transmission systems, and range in size from 20 in. to 2 in. In addition, protection is being provided for the bottoms of 10 new 93,000-brl. storage tanks.

So many lines within a small area necessitated extra large units, and installations consist of 3 copper-oxide rectifiers and 12 gas-engine-driven generators. Two additional rectifier units protect the 10 tanks The available current is supplemented by a generator at the Southern Minerals Corp.'s gasoline plant. Units are all of the same size, which helps to obtain satisfactory spacing. Ground beds are set back 350–400 feet from the protected lines and are designed with sufficient metal for a minimum life of 2½ years. In an attempt to prolong life the ground-bed pipes have been filled with a carbon residue obtained from a near-by carbon-black plant. Of interest in connection with the gas-engine-generator-unit installation is the use of the fuel-gas line, suitably insulated, as the negative connection from the pipe-line to the generator. The current requirements for the protection of the 10 tanks have been minimized by precautions taken to protect the tank bottoms from the soil of the original foundation. J. C.

327. Crude Oil and Gasoline Pipe-Lines in the United States, May 1, 1941. G. R. Hopkins and F. S. Lott. *U.S. Bur. Mines. Information Circular*, No. 7196, December, 1941.—It is estimated that on May 1st, 1941, the crude oil pipe-line system in the United States involved a total length of 118,350 miles, an increase of 7770 miles since June 30th, 1936, when the previous survey was made. The total length of gasoline pipe-lines at the same date was 9001 miles, nearly double the figure estimated for 1936. Average diameter of trunk pipe-lines for crude oil is 8·4 in., the tendency being to lay far less small diameter pipe; actually 74 per cent. of the total trunk-line mileage in 1941 consisted of pipe of 8-in. and over in diameter. Diameter of gasoline lines ranges from 2 to 12 in., 6- and 8-in. sizes predominating. The technique of pipe-line construction, operation and maintenance has materially improved and has resulted in increased efficiency of transport with corresponding reduction in costs. In the construction field, aerial survey has become standard practice on long lines and has eliminated much of the slower pioneer survey work of earlier years. Another factor of importance is elimination of couplings for joining lengths of pipe in favour of electric welded seamless pipe. Operating pressures as high as 2000 lb./sq. in. are safely achieved by use of forged steel fittings, cast alloy-steel valves, stronger materials in compressor cylinders and in all other parts under stress. All these improvements have permitted an increase in distance between pump stations to 100 to 200 miles compared with the former practice of boosting at 40- to 60-mile intervals.

H. B. M.

Crude Petroleum.

328.* World Crude Oil Production by Countries by Years. Anon. *Oil Wkly*, 26.1.42. **104** (8), 42.—Crude oil output is tabulated yearly by countries from 1857 to 1941, the figures for the latter year being preliminary estimates. G. D. H.

329.* Salt Removal from Refinery Charging Stock. J. C. Albright. *Petrol. Engr.*, Nov. 1941, **13** (2), 94.—The Michigan crude processed at the Alma plant of Leonard Refineries, Inc., averages about 125 lb. salt (NaCl) per 1000 brl. Only part of this can

be washed out by the usual method of heating with added water and settling. Consequent difficulties were short-time runs, all too frequent cleaning of equipment, with expensive replacements due to corrosion, and the degradation of the liquid products, especially the kerosine cut.

A Petreco unit was installed in the crude charge line operating as follows. Water is pumped, at a rate of 150 brl. per 1000 brl. of crude, into the line carrying crude, heated to 190° F. An intimate mixture is produced by means of a back pressure valve which causes high turbulence and high velocity. The crude–water emulsion enters the desalting vessel where the electrified zone causes rapid separation of the water, the oil flowing from the top of the unit. The results are that salt is reduced to 6 lb. per 1000 brl., leading to increased running time, lower maintenance costs, and improved products.

J. C.

330.* Characteristics of California Crude Oils. R. C. Mithoff, G. R. McPherson, and F. Sipos. *Refiner*, November, 1941 **20** (11). 462–470. *Paper Presented before American Petroleum Institute.*—California crude oils differ markedly from most other crude oils produced in the rest of the United States in gravity, paraffinicity, sulphur content, and asphalt content. They also differ markedly among themselves in these factors. These wide variations in crude-oil quality lead to the necessity that companies processing California stocks should place considerable emphasis on crude-oil analysis. They also lead to wide variation in the refining methods required. In this paper, crude-oil-analysis methods used by Standard Oil Company of California are described briefly, the different qualities of the California crude oils are compared with those of oils produced elsewhere in the United States, and a brief description is given of the differences in the required refining processes.

After defining certain terms used in the classification and pointing out the difficulties in finding a truly satisfactory method of classifying California crude oils the following general remarks are made: Crude oils from the San Joaquin Valley fall into two main groups, produced in about equal volume. The first group includes the heavier and more naphthenic oils, most of them ranging in A.P.I. gravity between approximately 14 and 25°, and in characterization gravity from 19 to 23°. Up to about 1930, most of the valley production was of this type. Midway–Maricopa district produces oil representative of this type.

The second group includes lighter and more paraffinic crude oils, most of them lighter than about 30° A.P.I. gravity and with a characterization gravity between 26 and 30°. Kettleman, Coalinga Eocene, and Coles Levee are representative. Most of the production in this group is from fields opened in recent years—especially from deeper, older geologic zones. The relationship to geologic age appears to be general throughout California. Deep wells producing from geologically older strata usually yield lighter, more paraffinic oil of lower sulphur content than do shallower wells in the same field producing from geologically younger rock.

Typical crude oil from the Southern California fields is intermediate in gravity and paraffinicity between the two main San Joaquin Valley types, but is of appreciably higher sulphur content than is either of the two. However, stocks from the different Southern California fields differ widely among themselves in gravity, gasoline content, paraffinicity and sulphur content.

Most of the crude oil produced in the California coastal area resembles the lighter group of oils produces in the San Joaquin Valley. However, the coastal area also produces considerable oil of markedly different types, such as the high-sulphur low-gravity Santa Maria Valley crude oil.

The paper gives results on the gravity, viscosity, sulphur content, paraffinicity, and cracking of these crudes.

A. H. N.

Gas.

331.* Alternative and Auxiliary Fuels from Liquefied Petroleum Gases. G. Segeler. *Oil Gas J.*, 23.10.41, **40** (24), 41.—There are now 173 communities in the U.S. which are provided exclusively with some form of liquefied petroleum gas (l.p.g.) service. In addition, about 25 gas utility companies are using l.p.g. for alternative, emergency, or supplementary supplies.

The successful interchange of l.p.g. with manufactured gas, so that either gives satisfactory results in existing burner equipment, demands that l.p.g. shall be suitably adjusted as regards (*a*) air requirements for combustion, (*b*) calorific value, (*c*) density (which affects the rate of flow through jets, etc.), and (*d*) ignition and burning characteristics.

The methods which may be used to ensure that these requirements are fulfilled are discussed, and it is shown that in the case of propane, a fair compromise may be obtained by mixing with a "carrier gas."

The carrier gases which have been suggested and investigated include air, blast-furnace gas, blue gas, coke-oven gas, hydrogen, reformed, cracked, or partially burned natural gas, etc. In general, whilst such mixtures may be compounded to give good burning properties, their calorific values are higher than that of manufactured gas. For this reason, the primary use of l.p.g. by gas utility companies up to now has been enrichment of their product to attain a specified thermal value. C. G. G.

332.* Treating Makes Arkansas Sour Gas Usable by Industry. R. M. Sanford. *Oil Gas J.*, 13.11.41, **40** (27), 32.—During the past two years a number of fields producing large quantities of sour gas have been opened up in South Arkansas. Until recently the McKamie field was considered to produce a gas containing the greatest quantity of H_2S–4250 grains per 100 cub. ft., but the newly opened Patton field yields a gas with more than 9000 grains of H_2S per 100 cub. ft.

Formerly there was little industrial demand for gas in S. Arkansas and most of the production was piped off and flared. However, a number of large plants to be erected under the Government defence project are now prospective consumers of large quantities of sweetened gas in the district and desulphurization has had to be considered.

A 60-day experiment has been carried out with the McKamie gas using the Girbotol process. This is the sourest gas which has yet been considered for commercial use. The results of this test have not yet been fully released, but it has been found that the sulphide content of the gas can be reduced to a point which makes it suitable for commercial and domestic use at a cost estimated to be between 1½ to 2 cents per 1000 cub. ft. processed.

Plans are in hand for the erection of Government plants which would require about 75,000,000 cub. ft. sweet gas/day and it is considered that the State will in due course be able to assure industries a daily supply near 100,000,000 cub. ft. at a price of 4 cents/1000 cub. ft.

Only the McKamie field has reached a definite stage at the moment, but desulphurization plants will be made available for other fields as the demand for sweet gas increases. D. L. S.

Cracking.

333.* New Method for the Determination of Equivalent Cracking Conditions for Commercial Cracking Reactions. S. L. Neppe, *J. Inst. Petrol.*, February 1942, **28** (218), 27–35.—Empirical studies of cracking rates under different temperatures and times are concluded with the following points:

(1) A chart is given showing that a straight-line relationship exists between the factor F, for which velocity of cracking is doubled and the cracking temperature t. The relation can be expressed algebraically as $Ft = 0{\cdot}04t - 10$.

(2) An equation—

$$\frac{\theta_1}{\theta_2} = \left\{\frac{0{\cdot}04t_2 - 10}{0{\cdot}04t_1 - 10}\right\}^{17.32257}$$

(where θ_1 and θ_2 are the periods of cracking at temperatures t_1 and t_2, respectively), has been derived from theoretical considerations. This very closely defined the relation between time of cracking and temperature for ordinary commercial cracking under constant pressure for a definite yield of product.

(3) Another chart has been constructed which can be utilized in a most simple manner for converting cracking conditions at any one temperature or period into equivalent cracking conditions at any other specified temperature or period.

A. H. N.

334.* Carburization of Cracking-Still Tubes During Service. C. L. Clark. *Oil Gas J.*, 27.11.41, **40** (29), 69.—Carburization on the inner wall of cracking-still tubes was investigated by a variety of laboratory mechanical tests on tubes made of the following steels: (*a*) 5 Cr Mo, (*b*) 7 Cr Mo, (*c*) an austenitic 18 — 12 + Cb. When carburization was relatively slight it was revealed by the flattening test, since slight deformation caused cracking in a ring section, whilst an adjacent section from which the carburized layer had been removed by machining could be completely flattened without the appearance of defects. A more pronounced degree of carburization may considerably decrease the room-temperature impact resistance and the ductility, but the Charpy impact resistance at 1200° F., a representative metal-operating temperature, does not appear to be influenced detrimentally. It is suggested that carburization occurs on the inner wall, especially at the fire side, much more often than is commonly supposed and that carburized tubes should not be subjected to shock at room temperature, as by a knocking type mechanism for removing coke. J. C.

335.* Reaction Chambers of Thermal Cracking Units. R. C. Mithoff and L. F. Schimansky. *Refiner*, November 1941, **20** (11), 427–431. *Paper Presented before American Petroleum Institute.*—Eight cracking units having a total raw-feed capacity of approximately 90,000 brl./day have been installed by one company in recent years. The results have been highly satisfactory.

In this paper correlations are presented relating reaction-chamber size with results obtained by the use of these chambers. It is shown that their use increases the severity of cracking of the gas-oil component of the raw-feed, and decreases the severity of cracking of the asphaltic component. This results in production of cracked residuum of lower sediment content and increased viscosity, and of cracked gasoline with increased volatility and higher octane number. Use of chambers also results in increased plant capacity, due to decrease in the heat requirement for cracking, to reduction in tube coking, and to improved furnace conditions.

These advantages result in appreciable decrease in the manufacturing cost of cracked gasoline. It is believed that installation of additional reaction chambers on many of the cracking units in use in the U.S.A. would be advantageous.

The paper gives details regarding the theory of reaction chambers and thus the expected advantages of cracking chambers over the two-coil operation. The method of correlating the results obtained is described and a correlation factor is used which, although not so rigorously accurate from theoretical view-points as other more complicated methods, is believed to be satisfactory from practical considerations.

Plant capacity and economics are briefly outlined, together with the advantages accrued. A. H. N.

336. Patent on Cracking. R. M. Melaven. U.S.P. 2,270,812, 20.1.42. Appl. 31.12.38. —Conversion of heavy hydrocarbon oils into gasoline by vaporising and subjecting the vapours at a temperature between 700 and 1050° F. to the action of a solid, porous contact catalyst consisting essentially of silica gel, the surface of which is coated with a layer of thoria. Afterwards the vapours are cooled and the gasoline recovered from the products. H. B. M.

Hydrogenation.

337. Patents on Hydrogenation. Anglo-Iranian Oil Co. E.P. 542,500, 13.1.42. Appl. 2.4.40. A two-stage continuous process for the conversion of paraffin hydrocarbons into naphthenic or non-aromatic cyclic hydrocarbons. First the hydrocarbons are contacted with chromic oxide or molybdic oxide at a temperature between 400 and 700° C. to produce a reaction product comprising aromatic hydrocarbons and hydrogen. Then this reaction product is contacted with a hydrogenating catalyst under conditions of temperature and pressure favourable to conversion of the reaction product into naphthenic hydrocarbons.

C. M. Thacker. U.S.P. 2,266,520, 16.12.41. Appl. 27.6.38. Dehydrogenation of paraffinic hydrocarbon gases by contacting at reacting temperatures with a catalyst

consisting of activated alumina, prepared by precipitating the trihydrate of alumina from an aluminate solution and calcining the precipitate at a temperature between 300 and 800° C., and a vanadium–oxygen compound.

V. N. Ipatieff. U.S.P. 2,270,303, 20.1.42. Appl. 25.2.38. Continuous process for the hydrogenation of octenes which comprises subjecting the vapours in admixture with a molal excess of free hydrogen to contact with catalytic material consisting of approximately 62% nickel, 4% oxygen combined in nickel oxide, 6% graphite, and 28% kieselguhr. H. B. M.

Polymerization and Alkylation.

338.* Lion Revamps Recovery System . . . to Better Supply Polymerization Unit. W. T. Ziegenhain. *Oil Gas J.*, 4.12.41, **40** (30), 37.—A vapour-recovery unit and a catalytic-polymerization unit have been placed in operation so that they can work independently or in conjunction. The vapour-recovery plant processes refinery gases, the daily charge averaging 2,000,000 cubic feet, of which 85% is cracking-still gas. The cooled charge, compressed to 105 lb. per sq. in., is scrubbed with oil in the absorbers. The resultant rich oil passes through lean-to-rich oil exchangers and enters a flash drum, where a portion of the light fractions flashes overhead to the stripping still. The flashed rich oil is then further heated before flashing into the still, which is equipped with a reboiler. The lean oil passes through lean-to-rich oil exchangers to an oil cooler, whilst unstabilized light gasoline, the overhead product, is condensed and collected in the stabilizer feed accumulator.

To recover the maximum quantity of C_3 and C_4 unsaturated hydrocarbons for poly-feed stock, some stabilized gasoline is recirculated into the condensed stripping still overhead. Uncondensed gases from the stabilizer-feed accumulator enter a re-absorber to recover propane and butanes not reclaimed in the main absorber. The unstabilized gasoline goes to a conventional stabilizing unit, which yields a light blending material as bottoms, whilst the overhead passes to a Girdler desulphurization unit, where it is mixed with cracked gasoline stabilizer overhead. The combined gases are caustic and water washed, compressed, condensed, and collected as liquid in the poly-feed accumulator. The liquid feed is pumped through a heater into two catalyst chambers in series. The effluent is cooled and flashed into the depropanizer whilst the bottoms product, consisting of poly-gasoline, butane, and some propane is passed to the debutanizer, where commercial butane is produced as overhead. The bottoms product is 12 lb. vapour pressure poly-gasoline with a motor-fuel blending value of 115. J. C.

339. Patents on Polymerization and Alkylation. G. B. Hatch, E. F. Pevere, L. A. Clarke, and F. H. Bruner. U.S.P. 2,267,097, 23.12.41. Appl. 30.8.39. Continuous alkylation of *iso*paraffin hydrocarbons by reaction with olefin hydrocarbons in the presence of a liquid alkylation catalyst of greater density than the hydrocarbons undergoing treatment.

A. R. Goldsby. U.S.P. 2,267,457, 23.12.41. Appl. 4.8.38. Production of alkylated hydrocarbons by the interaction of *iso*paraffins and olefins. The hydrocarbons are reacted with the olefins in contact with strong sulphuric acid at optimum pressure and temperature. As the strength of the sulphuric acid decreases the reaction temperature is increased.

A. V. Grosse and C. B. Linn. U.S.P. 2,267,730, 30.12.41. Appl. 31.12.38. Method of synthesizing hydrocarbons which comprises reacting an *iso*paraffin with an olefin under alkylating conditions and in the presence of an alkylating catalyst consisting essentially of hydrogen fluoride.

F. H. Bruner. U.S.P. 2,269,250, 6.1.42. Appl. 11.5.39. Alkylation of *iso*paraffin hydrocarbons with olefin hydrocarbons including C_4 and C_3 olefins. A hydrocarbon fraction comprising olefins and paraffins having 4 or more carbon atoms per molecule

is subjected to contact with a liquid alkylation catalyst in the presence of an iso-paraffin hydrocarbon in a reaction stage maintained under sufficient pressure to keep C_4 hydrocarbons in the liquid phase. A stream of used catalyst is continuously withdrawn and a C_3 and lighter hydrocarbon fraction injected into the stream. In this way olefins are absorbed and non-olefins rejected. Rejected hydrocarbons are removed and the stream containing olefins is returned to the reaction process.

H. B. M.

Synthetic Products.

340.* Synthesis and Properties of Hydrocarbons of High Molecular Weight. J. N. Cosby and L. H. Sutherland. *Refiner*, November 1941, **20** (11), 471–480. *Paper Presented before American Petroleum Institute.*—This paper is a summary of the first 16 months' work on American Petroleum Institute Research Project 42, on the synthesis and properties of hydrocarbons of high molecular weight, at the Pennsylvania State College. The synthesis of these hydrocarbons had as objectives the obtaining of data: (1) To permit conclusions on the effect of chemical structure on physical properties in the higher-molecular-weight ranges. (2) To furnish data on hydrocarbons of high molecular weight of value in identification of hydrocarbons or hydrocarbon mixtures isolated from petroleum. (3) To afford data useful in chemical-engineering calculations on petroleum fractions above gasoline. (4) To provide the industry with reliable methods of preparation and purification of hydrocarbons of high molecular weight which will be useful guides when the need arises for preparing larger quantities of such hydrocarbons.

Twenty-two hydrocarbons ranging in molecular weight from 344 to 450 have been prepared, with a purity of 95% or better. The following physical properties have been determined on each of these hydrocarbons: (1) Kinematic viscosity at 68, 100, 140, and 210° F. (2) Kinematic viscosity index by the Dean and Davis method. (3) Density at 68, 100, 140, and 210° F.; gravity, in °/A.P.I., calculated. (4) Melting point taken from melting curve. (5) Boiling points from vapour-pressure curve over the range 0·5 mm. to 5·0 mm. (6) Heat of vaporization, calculated for the range 0·5–5·0-mm. pressure. (7) Refractive index at 20, 30, and 40° C. (8) Specific refraction, calculated at 20° C. (9) Mean and specific dispersion at 20° C. Measurements of other physical properties are in progress.

Several generalizations have been pointed out in the relation of physical properties to structure. Application of the data presented in this paper has been made in checking the work of Kurtz on molecular volume. A. H. N.

Refining and Refinery Plant.

341.* Evaluation of Granular Adsorbents for Petroleum Refining. O. FitzSimons, R. C. Amero and R. G. Capell. *Nat. Petrol. News*, 29.10.41, **33** (44), R. 339.—The test procedure consists of screening the adsorbent to a standard size, heat-activating it under standardized conditions, and packing it into a column which provides for temperature and oil-throughput rate control. Efficiency is adjudged by a colour measurement of the contacted oil, a criterion being supplied by a standard reference clay. In the article, tabulated results are discussed in terms of particle size, activation, and filter-bed depth of the clay and rate of percolation of the oil. H. G.

342.* Greater Use of Coal in Refineries. Anon. *Nat. Petrol. News*, 29.10.41, **33** (44), R. 346.—A questionnaire has been circulated to a sample of refineries and seeks pertinent information concerning the extent to which coal or coke is used as under-boiler fuel and with a view to indicating the future tendency as between these fuels and oil or gas. There are no indications that the demands of the petroleum industry will cause a coal shortage. The use of coal appears to be an expedient, the desiderata being mainly economic. Coal has replaced gas largely because of those demands for gas which show a greater financial gain. H. G.

343.* New Lubricating Oil-Decolorising and Clay-Reactivating Process. W. B. Chenault and A. E. Miller. *Nat. Petrol. News*, 26.11.41, **33** (48), R. 374.—The process consists of continuously decolorising lubricating oil with clay and the continuous recovery of the clay by extraction with suitable solvents. "Magnesol" is the clay used and the colour solvent is a mixture of 45% acetone and 55% naphtha. Contacting is carried out at a temperature of 400–415° F. (furnace outlet temperature). The charging stock has been Pennsylvanian neutrals and raffinate on which an average clay life of 1030 brl. per ton has resulted. H. G.

344.* Increasing Capacity from Old Oil Heaters in Refineries. R. Reed. *Oil Gas J.*, 23.10.41, **40** (24), 34.—The rate of heat transfer in old tubular type heaters may be increased either by increasing the tube surface or by modifying the combustion conditions in the heater. Generally, the former operation is both difficult and expensive, but many of the older heaters leave room for considerable improvement in combustion conditions.

In recent years, the average heat release in such heaters has risen from about 10,000 B.Th.U. per cu. ft. of combustion space to about 18,000 B.Th.U. per cu. ft., partly as a result of more efficient burner design. By replacing older burners with modern units giving efficient flaring and low discharge velocity, more efficient circulation is obtained over the tube bank in the radiant portion of the furnace.

The amount of excess air supplied to the burner plays an important part in the performance of the heater. Reducing this excess to the lowest possible amount results in higher combustion temperature and in lower heat loss up the stack.

Cases are cited where improvements of up to 100% in operating rates have been obtained by applying these principles to old heaters. C. G. G.

345.* Hot Clay Treatment for Removal of Sulphur from Gasoline. H. Bottomley. *Nat. Pet. News*, 15.10.41, **33** (42), R. 330.—A method for the desulphurization of gasoline is described and compared in results with other refinery methods. As a preliminary to this study the author tabulates the sulphur content of various crude oils and gasolines from U.S.A. fields. A list is given of the various possible methods: (1) multi-stage caustic wash, (2) solutizer treatment, (3) caustic-methanol extraction, (4) hot clay treatment and its variations, and (5) sulphuric acid treatment. The five methods are compared and results are tabulated. A. H. N.

346.* Designing Insulation for Hot Refinery Lines. R. G. Lovell. *Petrol. Eng*, October 1941, **13** (1), 23.—Efficient heat insulation of steam lines and hot oil lines is considered from the commercial point of view. A comprehensive chart is presented to enable refiners to deduce the economical thickness of insulation in relation to various factors, such as the value of the heat in dollars, the hours of operation per year, the temperature difference, the cost and conductivity of the insulation, the shape of the surface, and the per cent. annual fixed charges.

Whilst heating liquids by direct steam injection is impracticable for most refinery purposes the method of calculating the quantity of steam required is shown by a worked example.

Heating liquids by steam coils is, however, a method of great importance in refineries and, since the maintenance of a high temperature differential is necessary for rapid heat transfer, it follows that the heated stock adjacent to the transfer system must be instantly replaced with cooler stock. Therefore, to increase efficiency of heat transfer it is necessary to circulate the liquid and it is shown that, because of its lower specific heat, oil must be circulated more rapidly than water. Charts giving B.Th.U. loss per sq. ft. of pipe surface from copper, brass and iron pipe and quantity of steam condensed per sq. ft. of pipe surface per hour enable various problems to be solved and examples are provided.

The article concludes with a brief discussion of the relative merits of saturated *vs.* superheated steam for heat transfer. J. C.

347.* Gas Purification Plant in Magnolia Field, Arkansas. F. H. Love. *Petrol. Engr*, November 1941, **13** (2), 31.—A description, with a flow diagram, of the Lion Oil Co.'s

plant for the removal of hydrogen sulphide and carbon dioxide from natural gas by the Girbotol process. The gas stream, at 150 lb. pressure and 100° F., enters the bottom of the absorber tower, passes upwards through Raschig rings, and is contacted by a solution of diethanolamine flowing counter-currently. The desulphurized gas is used for fuel, whilst the used diethanolamine flows from the base of the absorber to the bubble-tray reactivator tower, from which the stripped reagent returns to the absorber, the cycle being continuous. The installation, patented by the Girdler Corporation, provides for the treatment of 15 million cu. ft. of natural gas daily.

J. C.

348.* Details of New Refinery Installation on Louisiana's Gulf Coast. H. L. Flood. *Petrol. Engr*, November 1941, **13** (2), 34.—The new Lake Charles Refinery of the Continental Oil Co., described as a " combination topping, cracking, gas reversion, thermal polymerization, and alkylation unit " is one of the most important single additions to Gulf Coast refining capacity and is said to be one of the most efficient plants ever constructed. It is claimed that practically every hydrocarbon is utilized in the integrated processing of the combination charge of 10,000 brl. of crude oil and 6000 brl. of 70 lb. P.B.C. (propane–butane–casing-head) daily. The plant is complicated, including much recycling, and the description is amplified with a flow diagram, photographs and tables.

Crude Oil Processing.—The crude is pumped through a series of heat exchangers, passes to the 3-coil furnace and thence to the crude tower. The products from the crude tower, after suitable treatment and stripping, etc., are gasoline, naphtha, kerosine, and diesel fuel, whilst the topped crude from the base of the tower goes to the viscosity-breaker accumulator in the evaporator tower. There it is joined by heavy recycle and is transferred to the viscosity-breaker coil in the 3-coil furnace. The resulting cracked oils join the output of the gas-oil coil, the mixed stream passing to the soaking drum, where additional time is provided for the cracking reaction. The cracked stock goes to the evaporator, which may be regarded as the utility vessel of the plant, dealing with a variety of stocks, including (1) the mixture of gas-oils from the viscosity-breaker coil and from the gas-oil coil, (2) the output of the reversion equipment, (3) polymer gasoline from the partial stabilizer, (4) polymers removed from cracked gasoline. The evaporator separates a marketable fuel oil and cleans the stock used to charge the gas-oil coil in the 3-coil furnace. The latter stock goes to the bubble-tower, the overhead from which is cracked gasoline, which is clay-treated and then goes to the after-fractionator tower, where polymers and heavy ends are removed. The polymer-free cracked gasoline passes through the high-pressure gas separator and the cracked-gasoline debutanizer tower and is then blended with *n*-butane by means of a ratio-controller. It is washed with caustic, copper-treated and is then ready for blending to produce motor-grade gasoline.

The gas from the high-pressure separator, etc., goes to the absorber tower where it is treated with gas-oil taken from the stripping tower.

The bottoms from the bubble-tower constitutes clean stock for the gas-oil coil in the 3-coil furnace, after passing through which it joins the output of the viscosity-breaker coil and goes to the soaker drum.

From a " boot " on the side of the bubble-tower gas-oil is taken for a variety of uses including reboiling, refluxing, and absorption.

Casinghead Stabilization.—The P.B.C. enters the casing-head stabilizer tower to be stabilized to a natural gasoline, the properties of which are varied according to market requirements and which is pumped to storage without sweetening. The overhead, consisting mainly of propane, butane, and *iso*butane, goes to the depropanizer feed-drum, which also receives hydrocarbons resulting from cracking operations.

Polymerization Plant.—The mixed charge from the depropanizer feed-drum goes to the depropanizer tower and the overhead, propane, joins butane from the alkylate debutanizer as charging stock for the thermal polymerization furnace. From the furnace the stock goes via exchangers and reboilers to the partial stabilizer, the overhead from which consists of non-polymerized propane and butane which is recycled. Polymer distillate from the base of the partial stabilizer goes to the evaporator for cleaning.

Alkylation Plant.—The bottoms from the depropanizer tower are pumped to the combination alkylate reactor and acid settler, where the material is intimately mixed

with 98% sulphuric acid. The reactor effluent is neutralized with caustic, water washed, and then goes to the *iso*butane tower, which removes *iso*butane to be returned as recycle to the system. The bottoms go to the alkylate debutanizer, where butane is removed to be utilized as fuel, as charging stock for the poly furnace and for blending with cracked gasoline. The dubtanizer bottoms are fractionated into light and heavy alkylates, the latter being further fractionated in the after-fractionator tower, the heaviest fraction becoming cracking stock.

General.—The article includes a short description of the methods adopted for water, steam, power production, and water disposal, and also a discussion of yields.

An interesting feature of boiler operation is the installation of automatic equipment controlling the speed of the motors driving the stack draught fans. Change in volume of fuel is reflected in the draught, which gives uniformly high combustion efficiency automatically. J. C.

349.* Combating Organic Fouling of Cooling Water Circuits. F. J. Matthew. *Petrol. Times*, 27.12.41, **45** (1159), 752.—Cooling water systems offer practically an ideal medium for the development of algæ, protozoa, and other micro-organisms. These form slimes and accumulations in the system necessitating periodic shut-downs for cleaning.

It has been found that this trouble can be prevented by dosing the water with small amounts of chlorine gas.

A new method of treatment has now been developed whereby a reagent—sodium pentachlorphenate—is added to the water in the form of briquettes which slowly dissolve. This reagent is highly toxic to these organisms, the amount necessary to kill varying from 5 to 30 p.p.m. It is stable, non-volatile, freely soluble in water, and non-corrosive to the usual industrial metals in the concentrations used. Systems already fouled can be cleansed by maintaining a concentration of about 30 p.p.m. for 10 to 15 days and can then be maintained in a clean condition by a lower concentration.

The application of sodium pentachlorphenate requires no complicated equipment, the briquette being placed in wire baskets hung in the circulating water stream or alternatively bags of the material may be immersed in the water. The operating cost is low, amounting in several large industrial systems to 3*s*. 4*d*. per week per million gallons water.

The compound is not highly toxic to man in the concentrations used, but it is recommended that water so treated should not be used for drinking or bathing purposes.

D. L. S.

350.* Naphtha Treating. C. F. Mason, R. D. Bent, and J. H. McCullough. *Refiner*, November 1941, **20** (11), 432–435. *Paper Presented before American Petroleum Institute.*—The method of caustic-methanol treatment of naphtha is discussed. This process removes essentially all mercaptans from sour gasolines by extracting them with only 2% of strong caustic and a suitable quantity of methanol. The spent reagent is regenerated by steam-stripping and fractionation, and can be used indefinitely for mercaptan extraction.

The paper presents pilot-plant studies of the extraction and regeneration steps. Data are given on reagent losses, utility consumption, control of the stability characteristics of the finished gasoline, and improvement in octane number and lead susceptibility over the untreated gasoline. The increase in leaded octane numbers of the treated products usually will offer an attractive saving in lead additions. The process is ready for full-scale application. Several large plants are under way.

The economics of the process are discussed and it is stated, on the basis of certain data, that manufacturing cost of approximately 1·0 cent./brl. of naphtha, including reagent loss, is reached. From the standpoint of lead susceptibility and octane number, the previously mentioned data show that, in the average application, at least 0·25 ml. of tetraethyl lead/gall. of gasoline can be taken as a credit and, in many cases, a considerably higher figure will be obtained.

From the plant-investment cost angle, precise figures are difficult to give, due to variations arising as a result of differences in capacities and local conditions. It is believed that, for a plant of reasonable size—say 5000 brl./day—the investment will range from $8 to $2/brl./day.

A strong plea is made to discard the doctor test on the basis that at various times

during the experimental programme the product from the caustic-methanol plant has run slightly "off doctor" for long periods of time, and yet the actual mercaptan content of the gasoline was lower than the "OK doctor" product from the doctor-treating plant running on the same stock and alongside it. A. H. N.

351.* Precise Commercial Fractionation in 1000-Barrel Stedman Unit. L. B. Bragg and F. Morton. *Refiner*, November 1941, **20** (11), 457–461. *Paper Presented before Americam Petroleum Institute.*—The paper describes the design and operation of a commercial fractionation unit (1000 brl./day) utilizing Stedman packing. The tower is packed with Stedman packing having a cross-sectional area of 78·5 sq. ft. and a packed height of 7 ft. Full details of the design are given, with flow sheet and photographs. Three different types of operation are described.

(A) Fractionation of a straight-run gasoline into seven narrow-boiling fractions, a composite slop fraction, and a still residue. Two of these fractions which contain, respectively, substantially pure *n*-hexane and *n*-heptane and the residue may be isomerized, cyclized or reformed. The other fractions, containing substantially all the *iso*paraffins, naphthenes, and aromatics, and the *n*-pentane may be variously reblended to give high-octane-rating complementary spirits suitable for blending with *iso*-octane or alkylates to give 100 + aviation fuels.

(B) Fractionation of special fractions—the example given being the production of a concentrate of isomeric hexanes from a low-octane-rating gasoline, the fraction so obtained having a leaded octane rating of greater than 100.

(C) Fractionation of a narrow-boiling sidestream from conventional topping unit (boiling range 210° to 250° F.) to give substantially pure toluene.

The operations described indicate the commercial feasibility of large-diameter columns packed with Stedman packing, and show that narrow-boiling fractions can be obtained with a high degree of separation. For specific fractions, such as the production of substantially pure hydrocarbons, it will be necessary to use a greater packed height than has been used in the operations under discussion.

As has been indicated the batch Stedman unit offers the possibility of making a large number of cuts from a single charging stock, with good control and exact fractionation, even with varying feed composition. The present state of the art of controlling continuous bubble-tray batteries does not permit satisfactory operation to meet such requirements. In addition, batch operation permits one to take advantage of the possibility of using reduced reflux ratios in the early stages of the run, thereby reducing utility consumption and the size of the tower, condenser, and heating coils. Batch operation permits wide flexibility in the operation of the unit such as may be required to meet changing market demands.

Stedman packing is also particularly suitable for use: (*a*) in continuous-distillation units, with charging stock of substantially constant composition; (*b*) when a large number of theoretical plates is required; (*c*) when a low friction loss per theoretical plate is necessary; and (*d*) when moderate to high efficiency columns of small diameter are desired. A. H. N.

352.* Turbines for Power Generation From Industrial Process Gases. J. Goldsbury and J. R. Henderson. *Refiner*, December 1941, **20** (12), 505–514. *Paper presented before American Society of Mechanical Engineers.*—The use of turbines driven by process gases in order to conserve power and to cool gases economically is advocated. The most important development so far in the use of turbines driven by industrial process gases other than steam is found in connection with certain catalytic petroleum refining processes. In these processes carbon is deposited on the catalyst. The carbon must be burned off and the catalyst regenerated at frequent intervals. In several of these processes it is apparently most effective and economical to burn off the carbon under pressure. In some cases the pressure is as high as 300 lb. and much higher pressures have been proposed. Several catalyst retorts are frequently used so that one or more can be undergoing the regeneration processes continuously. The maximum regeneration temperature is controlled either by tubes through which a coolant is passed or by recirculation of some of the products of combustion which have passed through a waste-heat boiler or by other suitable means. There is, then, a steady flow of these products of combustion or flue gas which is of no further use to the process. The heat

could, of course, be partially recovered in a waste-heat boiler or other type of heat exchanger, but the pressure potential would be largely wasted. The pressure potential can be utilized and a large portion of the heat removed by passing the gas through a turbine.

A 3500 h.p. flue-gas turbine is studied briefly and the method of governing its speed is explained. Similarly, a flue-gas turbine working in conjunction with a steam turbine, both being controlled by one governor, is discussed. A special detailed study is made of natural gas as elastic fluid for turbine purposes. Methods for calculating available energy for different pressure drops in complex mixture of gases are explained in full details. P-V-T and k data are collected from the literature and reproduced here.

It is pointed out that certain processes may be improved or operated more economically by the installation of turbines to derive power from the expansion of gases the energy of which might otherwise be wasted or inefficiently used. In some cases the reduction in temperature resulting from expansion through a turbine may be more important than the power obtained. By expanding gases through turbines rather than wastefully through valves and small pipe-lines, power can often be derived which will replace power derived from the burning of fuel and thus help to conserve fuel. A. H. N.

353.* **Straight-Line Fractionation.** Anon. *Refiner*, December 1941, **20** (12), 530–531.—Fractionation and treating are combined in one series of operations in the plant described. Five columns following the steam distillation equipment are operated to de-ethanize and remove hydrogen sulphide, manufacture and dry propane, separate isobutane from normal butane and produce natural gasoline to specifications. Immediately following the column employed for removing ethane and reducing hydrogen sulphide content is a caustic contactor to complete the removal of H_2S. A horizontal caustic settler is next in line followed by a vertical vessel filled with standard grades of sand to dry the gasoline and prevent passage of entrained treating solution to the sweetener. The sweetener is the type which makes use of cupric chloride carried in a bed of fuller's earth to convert the mercaptans to disulphides. The gasoline-treating system is stepped into the straight-line process following the de-ethanizing column, so that the gross product is sweetened in a single operation instead of treating each product separately.

Certain details of the plant and products are given. A. H. N.

354.* **Water and Chemicals Accomplish Salt Removal.** Anon. *Refiner*, December 1941, **20** (12), 535–536.—The major portion of salt content, 70 lb./1000 brl., are removed by this system. The first step is the introduction of 6% by volume of fresh cold water through a mixing nozzle so as to form an emulsion. Then a treating chemical is introduced after the charge takes its first preheat by exchange. After a second preheat by exchange the raw charge passes to a desalting drum. The combination reduces salt content to around 7 lb./1000 brl.

Fresh water is introduced at the suction of the reciprocating charge pump and is metered for accuracy. After gaining the contact provided by a special mixing nozzle, the charge goes to the first of three heat-exchanger units, where sufficient heat is provided to permit chemical action and the emulsion-breaking agent is introduced at this point.

In the second topped-crude-to-charge-stock heat exchanger, temperature is raised to around 300°, after which the oil, water, and chemical enter the horizontal desalting drum, 6 ft. in diameter and 43 ft. long, where the water is drawn off and the oil continues through the topping plant.

This vessel is mounted on concrete piers with one end 30 in. higher than the other. The charge enters the drum at the top of the shell at the low end, passing to the interior through a perforated line extended along the bottom for 16 ft. Baffles are used inside the drum to bring about complete separation of the aqueous solution from the oil. Tell-tale cocks at the lower end of the drum are used to determine the water level, which is controlled by bleeding to disposal lines continuously.

Other details are given. A. H. N.

355.* **Continental Plant Designed for Flexible Operation.** Anon. *Refiner*, January 1942, **21** (1), 1–8.—Outstanding features of this unit are: a close integration of crude

distillation, visbreaking, gas-oil cracking, naphtha reversion, clay treating, debutanization, thermal polymerization, catalytic alkylation, ability of portions of the unit to function when other parts are not operating, centralized control of entire unit, manufacture of high-octane gasoline, including aviation alkylate, from field gases, and ability to produce a wide variety of products by change of operating conditions.

The Lake Charles plant was designed to charge Ville Platte crude, a low-sulphur oil containing 35 to 40% of 400 end-point gasoline, although Tepetate crude is also being processed. Alternate design conditions called for (1) charging 7000 brl./day of crude and about 6100 brl. of 70-lb. R.V.P. field casing-head, or (2) 10,000 brl. of crude and 6100 brl. of raw casing-head. Specified yields were set for either condition. In general, operation has coincided closely with design conditions both as to yields and quality of products. In addition the unit has been producing alkylate.

Both the Ville Platte and Tepetate crudes are stabilized in the fields by removal of propane and some of the butanes. Gases lighter than these also are removed and used for pressure maintenance of the oil sands. Propane and butanes are blended with natural gasoline and the blend is carried by pipe-line to the refinery. The crudes are also piped in. A desirable characteristic of these feed stocks is that they are relatively free of sulphur. This made practicable limited use of alloy steels.

Operation of the unit consists of four fundamental steps: crude distillation, cracking (including reversion), thermal polymerization, and sulphuric-acid alkylation. The entire unit need not be operating at any given time, a fact of importance when some portion needs to be shut down for cleaning or repairs. The cracking system, of course, can run alone as long as the crude system is functioning. The casing-head stabilizer can run alone. The alkylation system can operate if the cracking system is on stream. The polymerization system can run if aided only by the casing-head stabilizer. The four steps are described in some detail. The design and construction of the plant is also discussed.

A feature of the unit is the economical manner in which steam is used. The refinery steam is generated in two 1100-h.p. boilers producing 350-lb. steam and provided with stack draft blowers automatically regulated to vary in speed according to the boiler load. Three turbines, one driving the 4-stage centrifugal charging the visbreaker coil, another driving the 6-stage centrifugal charging the gas oil cracking coil, and the third driving a horizontal triplex power pump charging the polymerization furnace, take 350 lb. steam and exhaust to 150 lb. A portion of this exhaust is used in the crude system, evaporator, and bubble-tower as stripping steam. The remainder enters a superheater and emerges still at 150 lb. Part of this superheated steam is used in six reboilers. The rest drives the circulating pumps, with the exception of those with motor drives. These circulating pumps exhaust 15 lb. steam. Some of this steam is used in the refinery feed-water heater and the remainder goes to two reboilers. Part of the condensate from the 8 above-mentioned reboilers is used in the steam superheater and the rest returns to the boilers. A. H. N.

356.* Rôle of Blending in the Production of Aviation Motor Fuel. E. S. Bissell. *Refiner*, January 1942, **21** (1), 9–15.—Blending by means of pump recirculation utilizing swing lines, pipe spiders, venturies, or a combination of these is discussed and illustrated. It has been found that the average overall efficiency ratio between an in-tank propeller-type mixer and the method of pump recirculation, is approximately 10 to 1. In other words, an efficient pump recirculation system will require 10-h.p. hours to 1-h.p. hour of the propeller-type mixer. The method of comparison is detailed.

In general, a propeller-type in-tank mixer when compared with a pump, is not called upon to overcome head losses, pipe friction, and casing friction. There is no violent change in direction in the propeller-type mixer, as the feeding is done from a large area back of the propeller and in all directions radiating from the axis. The entire energy at the propeller is imparted directly to the liquid, and since there is no pipe friction or casing losses, all of this energy is turned into mixing effort. The stream leaving the propeller is not a uniform stream flow such as leaving a nozzle or pipe, with all components moving in a forward direction, at the same velocity. A three-bladed propeller creates three helical paths for the liquid which moves forward at an average forward stream velocity, which can be approximated by multiplying the pitch of the propeller

times its r.p.m. times 70%. Particles in this stream, however, are also revolving in a spiral or helical path at a speed derived from the point on the blade from which discharge at the tip of the blades; the velocity of these components approaches the peripheral speed of the propeller, which is simply the circumference of the propeller times the r.p.m.

The following factors of the propeller-type in-tank mixer account for its high overall efficiency. First, the displaced stream is of large volume, insuring that the entire contents of the tank will be displaced or moved through the zone of high local turbulence at the propeller within a short time. Low per cent. components are rapidly dispersed when introduced into the tank near the propeller. Second, the stream velocity is sufficient to insure displacing additional volumes of liquid by its momentum in all parts of the tank. Third, the helical or spiral path induced at the propeller maintains itself throughout the tank (velocity decreases as distance from propeller increases), once the contents have been set in motion and initial inertia has been overcome. The existence of these local swirls in different parts of the tank is exhibited through the study of the phenomenon by high-speed photography and through the use of the stroboscope, as well as visual observation in the suspension of light solids. These swirls are not to be confused with a general around-and-around motion of the entire contents, but are of short duration and local existence, their size being directly proportional to the size of the propeller.

The position of the propeller and methods of installation as well as costs and losses are detailed. A. H. N.

357.* Tube Corrosion Held to a Minimum by Continuous Check on Dehydrator Water *p*H. J. S. Pfarr and H. A. Blackstone. *Refiner*, January 1942, **21** (1), 16–18.—At the plant in question corrosion arose mainly from the release of hydrochloric acid which, unless neutralized, attacked tubes and linings. By incorporating a *p*H measuring and recording system a check was maintained on corrosion with the result that a 10,000 brl./day combination skimming and cracking unit could be run for 218 days without corrosion of tubes. The principles involved as well as the installation of the system are discussed. A. H. N.

358.* Fundamentals of Refinery Piping Design. Part 1. A Cibulka. *Refiner*, January 1942, **21** (1), 19–27.—The stresses involved on heating pipes which are not allowed to expand are studied. These stresses are found to be high. Standard 12-in. pipe with a metal area of 15·71 sq. in. when heated only 100° F. produces a force of 150 tons. This force is the same, whether the pipe is 1 in. or 1 mile long. The elongation only varies directly with the length, but the force does not.

The coefficient of expansion is not a constant; with most materials it increases with temperature, while the modulus of elasticity usually decreases with the temperature. These facts must not be overlooked when calculating the total expansion and the forces produced.

The temperature change t produces in every square inch of cross-sectional area (if restricted) a force P given by the formula $P = \varepsilon t E$. Where E = modulus of elasticity of material (in lb./sq. in.). E for steel 29 to 30,000,000 (steels for cables vary between 20 to 32). Monel metal 25,000,000; copper rolled 17,000,000; copper case-hard 12,000,000; brass 10 to 13,000,000; aluminium 10,000,000; lead 1,000,000; glass 10 to 11,000,000.

ε = coefficient of linear expansion: steel at atmospheric temperature 0·0000065; copper at atmospheric temperature 0·0000177; bronze at atmospheric temperature 0·0000181; brass at atmospheric temperature 0·0000187 to 205; Admiralty at atmospheric temperature 0·0000202; Muntz at atmospheric temperature 0·0000208; aluminium at atmospheric temperature 0·0000122; lead at atmospheric temperature 0·0000163; glass at atmospheric temperature 0·000004 to 0·000006; KA2 at atmospheric temperature 0·0000089.

A complete solution of a typical problem is given where a statically indeterminate structure was involved. A. H. N.

359.* Increase in Refinery Power Requirements. R. Haldane. *Refiner*, January 1942, **21** (1), 28–30. *Paper Presented before Petroleum Electric Power Association.*—The paper discusses the effect of the increase in defence products on the power requirements of refineries in the U.S.A. A. H. N.

360. Patents on Refining and Refinery Plant. Refiners Ltd. E.P. 542,134, 29.12.41. Appl., 18.6.40. Refining of oils and spirits such as petrols, cracked spirits, naphthas, kerosenes, benzoles, and low temperature distillation spirits. The oils are treated with a catalyst obtained by the reaction of trihalogeno derivatives of elements of Group 111*b* of the Periodic Table with phenols. In this way the olefinic constituents of the oil or spirit are polymerized.

C. L. Walsh. E.P. 542,605, 19.1.42. Appl. 18.6.40. Treatment of viscous liquids such as dirty mineral or vegetable oils which, owing to their viscosity, are difficult to filter rapidly by ordinary methods. A colloidal gelatinous precipitate is formed in the liquid in the presence of finely divided magnetic material, so that suspended matter and the magnetic material are both entrained in and deposited with the colloidal substance. Afterwards the whole of the deposited material owing to the presence within it of the magnetic material is completely or substantially separated from the liquid by means of a magnetic separator.

T. O. Edwards and O. Larsen. U.S.P. 2,266,359, 16.12.41. Appl. 9.5.38. Method of treating petroleum oils which comprises contacting hydrocarbon oil containing acidic compounds with an alkali in the presence of water at a temperature between 200 and 500° F. Afterwards the contacted oil is fractionally distilled to remove not less than 97% as distillates, and a relatively low boiling fraction substantially free from acidic bodies is recovered from the distillation, together with an intermediate fraction containing acidic bodies and a bottoms fraction comprising 0·2–3·0% of the original charge.

L. D. Jones. U.S.P. 2,266,553, 16.12.41. Appl. 2.12.38. Method of dewaxing a mixture which consists of precipitated wax in an oil solution consisting of oil and a solvent of such character, and present in such amount, as to make said oil solution of lower specific gravity than the wax.

L. D. Jones. U.S.P. 2,266,554, 16.12.41. Appl. 11.7. 39. Method of dewaxing a mixture consisting of an oil solution containing precipitated wax of higher specific gravity than the oil solution. The solution is passed to a centifugal rotor and the wax stratified from the solution in a zone of the rotor free of stratifying discs to form a plastic wax stratum lying entirely within the unobstructed zone. A stratum of spacing liquid is maintained between the wax and the inner circumferential wall of the rotor. The oil solution from which the wax has been removed is then passed inwardly to a disc-bloc zone of the rotor and subjected to further centrifuging to remove residual wax. The oil solution is continuously discharged from the rotor; also the wax continuously and separately discharged from the wax stratum.

A. R. Goldsby. U.S.P. 2,267,458, 23.12.41. Appl. 18.8.38. Method of refining hydrocarbon oils containing objectionable sulphur, colour, and gum-forming compounds by subjecting them to treatment with used sulphuric acid which has been obtained from the alkylation of *iso*paraffins with olefins in the presence of strong sulphuric acid. In this way objectionable compounds are substantially removed.

A. E. Catanach and E. Kolthoff. U.S.P. 2,269,647, 13.1.42. Appl. 15.1.40. Process for neutralising an acid-treated oil of the lubricating type, derived from a petroleum distillate of high neutralization number. A caustic soda solution is used substantially to neutralize the mineral acidity of the oil without neutralizing the organic acidity. Thereafter the partially neutralized oil is treated with a rosin soap solution to settle out mineral salts and soaps. Finally the organic acidity of the oil is neutralized with caustic soda solution.

M. C. K. Jones. U.S.P. 2,270,058, 13.1.42. Appl. 15.5.40. Treatment of mineral oils containing objectionable sulphur compounds with an alkali metal aluminium silicate of the zeolite type at a pressure above 75 lb. per sq. in. and a temperature above 600° F.

W. L. Benedict and C. G. Dryer. U.S.P. 2,270,248, 20.1.42. Appl. 28.7.39. Method of sweetening sour hydrocarbon distillates by treating with an aqueous hydrogen halide solution and afterwards separating the distillate from the solution and treating the former with a sweetening agent containing combined copper and a combined halogen.

C. D. Lowry. U.S.P. 2,270,322, 20.1.42. Appl. 31.5.39. Treatment of sour hydrocarbon distillate with plumbite solution to convert mercaptans to lead mercaptides. Thereafter unconsumed plumbite solution is separated from the distillate and additional sour distillate combined with the latter. Sulphur is then added to the mixture to convert the lead mercaptides to lead sulphide. Finally the mixed distillates are washed with water to separate the lead sulphide.

S. E. Campbell. U.S.P. 2,270,411, 20.1.42. Appl. 26.1.39. Process for desalting oil which comprises agitating a petroleum oil containing particles of salt with a saline solution partly to dissolve the salt, and passing the mixture through a body of contact material substantially to dissolve the solid salt in the saline solution. The solution and the oil are separated immediately afterwards. H. B. M.

Analysis and Testing.

361.* Spectrophotometric Characterization of Lubricating Oils. C. R. Johnson and E. A. Garcia. *Refiner*, December 1941, **20** (12), 520–521.—A report is given in which the apparatus and procedure proposed for spectrophotometric characterization of lubricating oils are described in some detail, together with results already obtained. It is concluded that the colour of an oil may thus be specified by its percentage transmittance T of 30 millimicron bands of light of average wave-lengths, relative to Squibb's clear heavy Californian mineral oil as a reference liquid, in square curvettes 1·303 cm. in depth, at a temperature of about 25° C. The transmittances may be measured rapidly with the same sample of oil and reference liquid used in determining the spectral number, by the usual direct procedure. Transmittances measured with curvettes of any depth l cm. reasonably close to 1·303 cm. may be calculated to the standard transmittances defined above, by use of the Lambert law relation, $T_{\text{standard}} = 100\left(\frac{T_l}{100}\right)^{\frac{1\cdot303}{l}}$. A special slide-rule is available for this calculation.

The method has been related to other methods of colour description through the A.S.T.M. colour numbers of two sets of oils. A. H. N.

Motor Fuels.

362.* Sulphur Compounds in Petroleum and its Distillates. H. Bottomley. *Oil Gas J.*, 23.10.41, **40** (24), 37.—In order to study the effect of sulphur compounds on the T.E.L. response of gasolines, various blends of a sulphur-free gasoline with pure organic sulphides, disulphides, and mercaptans were prepared and examined, with special reference to octane number and T.E.L. response.

It is shown that the first small increment of added sulphur (0·01% wt.) affects the octane number to the greatest degree, and that five times this amount causes little further reduction in the octane number. The depressing action on the T.E.L. response, however, continues up to 0·05% sulphur, beyond which the investigation did not go.

Five methods used for desulphurizing gasoline are discussed, and the results of an experimental investigation of four of these methods are tabulated, showing the physical and chemical properties, with T.E.L. responses, of a West Texas straight-run gasoline before and after the various treatments. C. G. G.

363.* Refiners Fear Post-War Effects of 100 Octane Expansion. J. P. O'Donnell. *Oil Gas J.*, 13.11.41, **40** (27), 15.—Plans are in hand for the production of 120,000 brl. of 100 octane motor fuel daily in 1943–44. Conclusion of the war will be accompanied by an immediate decline in the demand for aviation spirit and the effect of the release of a great quantity of high grade motor fuel is causing some concern to certain refiners.

This concern is based on the belief that car manufacturers may produce automobiles that will be able to take advantage of the better fuels which may then be available and

that this may place a great burden on the producers of such fuel. The author believes that compression ratios will in fact continue to increase, but judging from the rate of increase over the past 14 years he believes that this will continue to be gradual and will not leap from the present 6·66 to the figure of 8—a satisfactory figure for 95 O.N. fuel.

It is pointed out that commercial aviation will probably demand much of the available 100 O.N. fuel after the war. In any case, a large increase in the production of this grade of gasoline would create a great demand for butane which could not be produced without lowering the O.N. of the gasoline supplied to the public. Again a shortage of anti-knock blending agents is a possibility.

All these facts indicate that little if any 100 octane fuel is likely to be available for the motoring public for some time after the end of the war. D. L. S.

364.* Improved Motor Fuels through Selective Blending. C. R. Wagner, W. B. Ross, L. M. Henderson, and T. H. Risk. *Refiner*, November 1941, **20** (11), 436–448. *Paper Presented before American Petroleum Institute.*—This long paper, which is given in 4 parts, is a report of the progress that has been made in a programme begun in 1938 to investigate the effect of the chemical composition of fuels on the road anti-knock performance and road lead susceptibility of these fuels. The data presented are based on the results of road tests of some 284 special fuel blends and approximately 200 commercial gasolines in 25 different cars. The border-line road-knock testing method was used throughout these tests, as it seemed best adapted to a study of fuels in accordance with the arbitrary definition of the " ideal " fuel set up at the start of the investigation. As defined for the purpose of these tests, an " ideal " fuel is one which will satisfy the anti-knock requirements of any engine in which it is used throughout the engine-speed range, but which will not possess any " wasted " or excessive anti-knock quality at any car speed. The results obtained to date indicate that the fuel which most nearly will satisfy this definition of the " ideal " fuel is one in which the light fractions are composed primarily of olefinic material and the heavy fractions are composed primarily of paraffinic material. Several ways of utilizing this information in the commercial production of motor fuels are suggested. There is, of course, the possibility that some of the newer existing processes, such as catalytic cracking and catalytic reforming, alone or in proper combination, may produce fuels which will meet these requirements with little or no alteration. Changes in refining equipment might entail the addition of a few specialized units to supplement present equipment or the construction of an entirely new plant. Before extensive equipment changes can be justified, the refiner should be sure that the new fuel will be relatively satisfactory for a number of years.

Throughout the work, the consideration of hydrocarbon analysis of a fuel in conjunction with its " motor " and " research " octane values has seemed to offer the best means of correlating road performance with laboratory data. It is shown that all fuels of two series of experiments were cut into either two or three fractions with respect to boiling range, and each fraction analyzed, separately for its content of aromatics, naphthenes, paraffins, and olefins. These tests have shown that any fuel containing large portions of olefinic material throughout the boiling range will tend to knock at high engine speeds, and will have relatively poor lead susceptibility not only in the laboratory, but on the road. A highly sensitive fuel, however, in which the high-boiling olefins have been replaced with heavy paraffins, aromatic, or naphthenic material will show considerably better road-lead susceptibility and considerably better high-speed performance. Fuels containing large amounts of paraffinic material in the light-boiling range, in general, will have poor low-speed anti-knock performance and poor lead susceptibility at low speeds; but if the low-boiling paraffins are replaced with light olefinic and/or aromatic material, low-speed anti-knock performance and low-speed road lead susceptibility usually will be improved. Although sufficient data are not available to permit the formulation of any quantitative procedure for predicting fuel road performance, the method outlined above does give reasonably accurate qualitative indications. Perhaps better correlation could be obtained if consideration were given to the " motor " and " research " octane values of the various fractions of a fuel obtained by simple distillation.

An appendix gives the method used in determining the composition of the gasolines tested. A. H. N.

365. Patents on Motor Fuels. F. E. Frey. U.S.P. 2,266,019, 16.12.41: Appl. 27.1.37. Continuous process for the production of normally liquid motor fuel hydrocarbons from a normally gaseous hydrocarbon mixture containing not less than 10% by volume of olefinic hydrocarbons predominantly ethylene and 50% by volume or more of paraffinic hydrocarbons of 3 or more carbon atoms per molecule.

M. L. Chappell. U.S.P. 2,266,848, 23.12.41. Appl. 4.3.38. Production of *iso*-paraffinic hydrocarbons boiling in the motor fuel range by reacting a paraffinic hydrocarbon containing at least three carbon atoms per molecule with acetylene in the presence of a metal oxide catalyst at a temperature between 350 and 400° F. and hydrogenating the resultant product.

C. L. Thomas and H. S. Block. U.S.P. 2,267,766, 30.12.41. Appl. 21.8.39. Production of substantially saturated gasoline of high anti-knock value by combining olefinic gasoline with hydrocarbon oil heavier than gasoline and subjecting the resultant mixture to the action of a cracking catalyst at a temperature between 600 and 900° F. In this way gasoline of low olefin content is produced and is separated from conversion products heavier than gasoline. At least a portion of the heavier products are cracked at a higher temperature than previously and olefinic gasoline and gas thus formed. Gaseous olefins are separated out and subjected to polymerization. The resultant polymers and olefinic gasoline formed during cracking are supplied to the first conversion process.

E. H. McGrew. U.S.P. 2,270,071, 13.1.42. Appl. 31.8.39. Conversion of hydrocarbon oils to produce gasoline containing a relatively small amount of olefinic hydrocarbons. A relatively high boiling hydrocarbon oil is subjected to thermal cracking treatment and concurrently a relatively low boiling hydrocarbon oil is subjected to thermal reforming. The products of the two processes are mixed together and fractionated to form light and heavy reflux condensate and to separate vapours boiling in the gasoline range. Simultaneously an oil boiling intermediate between the high and low oils is subjected to a high temperature catalytic cracking process and the resultant product mixed with the light reflux condensate. The mixture is then cracked for a sufficient length of time to effect substantial saturation of the olefin content of the gasoline.

C. L. Thomas and H. S. Block. U.S.P. 2,270,091, 13.1.42. Appl. 21.8.39. Production of substantially saturated gasoline of high anti-knock value by combining olefinic gasoline with hydrocarbon oil heavier than gasoline and subjecting the resultant mixture to the action of a cracking catalyst at a temperature between 600 and 900° F. In this way gasoline of low olefin content is produced and can be separated from conversion products heavier than gasoline. At least a portion of the heavier products are cracked at a higher temperature than in the first process, thereby forming olefinic gas and gasoline. The gases are subjected to polymerization and the resultant olefin polymers supplied to the first conversion process.

J. A. Wyler. U.S.P. 2,270,400, 20.1.42. Appl. 30.11.39. Method of accelerating the ignition of liquid fuels in an internal combustion engine by admixing to the fuel prior to ignition a minor proportion of tetranitromethane. H. B. M.

Chemistry and Physics.

366.* Chemical Composition is the Guide to the Perfect Anti-Knock Fuel. Anon. *Nat. Petrol. News*, 26.11.41, **33** (48), R. 370.—An abstract from "Improved Motor Fuels through Selective Blending." C. R. Wagner, W. B. Ross, L. M. Henderson, T. H. Risk, presented at A.P.I. refining session 7.11.41.

The article comprises preliminary results in an investigation of the development of the chemically ideal motor fuel with maximum anti-knock properties throughout the entire speed range. The present indications are that this fuel should contain low-boiling olefins, high-boiling paraffins, and aromatics or naphthenes. H. G.

367.* Progress Report on the Hydrocarbons in the Kerosine Fraction of Petroleum A.P.I. Research Project 6. F. D. Rossini and B. J. Mair. *Refiner*, November 1941, **20** (11), 494–498. *Paper Presented before American Petroleum Institute.*—In this progress report from A.P.I. Research Project 6, on that part of its work dealing with the isolation and identification of hydrocarbons in the kerosine fraction of petroleum, the following topics are discussed: present status of the work on the gasoline and kerosine fractions; outline of the separation of the kerosine fraction; properties of the hydrocarbons isolated; other hydrocarbons likely to be separated; amounts of the hydrocarbons in the kerosine fraction and in the original crude petroleum; significance of the work to the petroleum industry.

From data presented the following points are noted with regard to the distillate 200–230° C: (*a*) All the normal paraffin and 30% of the aromatic portion have been resolved with respect to pure compounds. The total resolved material represents about 20% of the distillate 200–230° C. (*b*) There remains to be resolved 70% of the aromatic portion and all the portion containing the *iso*paraffins and naphthenes. The total unresolved material represents about 80% of the distillate of the range 200–230° C. (*c*) There is a more or less regular relation in the relative abundance of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene, and of their partly hydrogenated derivatives, 5 : 6 : 7 : 8-tetrahydronaphthalene, 1-methyl-5 : 6 : 7 : 8-tetrahydronaphthalene, and 2-methyl-5 : 6 : 7 : 8-tetrahydronaphthalene.

It may well be that the analysis of the kerosine and other fractions below the lubricant fraction, because they are less complex, will yield more information, with less effort, about the composition of the lubricant fraction than a direct attack on the lubricant fraction itself. Already valuable information along these lines has been obtained. Thus the presence in the kerosine fraction of tetrahydronaphthalene and its homologues is consistent with the previous finding that the lubricant fraction contains compounds in which both aromatic and naphthene rings occur in the same molecule. Similarly, it has been shown previously that in the lubricant fraction those molecules containing two aromatic rings were in large part ones in which these aromatic rings were linked together through two carbon atoms, as in naphthalene and its homologues. As previously reported, these latter compounds have already been isolated from the kerosine fraction. A. H. N.

368.* Radial Temperature Gradients in Gas-Heated Tubes. L. E. Stewart, J. B. Green, and R. L. Huntington. *Refiner*, December 1941, **20** (12), 522–525.—Experimental results on radial temperature gradients, both in packed and gravel-free tubes, of various sizes were studied by means of radially placed thermocouples. The gas, which consisted of 95% methane, 3% ethane, and 2% nitrogen, was preheated in a copper coil before being passed into the bottom of the experimental tube. In some cases, with low rates of heat input, it requires as much as 4 or 5 hrs. to bring the tube to a steady operating state. This was particularly true for the 8-in. tube when it was packed with flint-rock gravel.

A gas meter (accurate within $\pm$ 1%) measured the natural gas before it was heated. Temperatures were held within a 5° F. range at the inlet of the tube during each steady state run. The temperatures were obtained from thermocouple readings on a potentiometer.

Radial and longitudinal variations of considerable values are reported. The gradients were as steep for insulated as for uninsulated tubes. A. H. N.

369.* Catalytic Hydrogen Peroxide Oxidation of Straight Chain Olefines. W. Treib. *Refiner*, December 1941, **20** (12), 532–534. Paper translated from *Brennstoff Chemie*, **20** (19), 358.—Researches on cyclic compounds have shown that hydrogen peroxide in the presence of suitable catalysts gives the same end products as does auto-oxidation and that, in contradistinction to the latter, labile intermediates do not suffer spontaneous polymerization (resinification), in fact, they are completely hindered by a special reaction technique. Employing either alkaline or acidic oxidation-reagents, the reaction proceeds without rearrangements, for instance, due to enolization or ketonizing of the molecule—which ordinarily might influence energy partitioning and the direction of the resulting equilibrium. It is for this reason important to determine the reactive positions in the molecule during the H_2O_2 oxidation in neutral solutions. On these

bases the work is extended to fields of the highly reactive olefines. As a catalyst pervanadic acid was found useful. Besides controlling the oxidation it acts as indicator during the reaction.

Results of several tests are presented briefly with explanations of the mechanisms of the oxidation reactions. A. H. N.

370. **Determination of Types of Suphur Compounds in Petroleum Distillates.** J. S. Ball. *U.S. Bur. Mines, Report of Investigations*, N. 3591, December 1941.—A technique of analysis for sulphur groups in petroleum distillates has been developed by the U.S. Bureau of Mines, in co-operation with the University of Wyoming, which is specially applicable to the high sulphur-bearing "black oils" of Wyoming, incidentally to similar crudes yielding only small percentages of straight-run light distillate and characterized not only by sulphur but also by a high asphalt content. The scheme of analysis makes provision for determination of sulphuretted hydrogen, free sulphur, mercaptans, disulphides, aliphatic sulphides, aromatic sulphides, and thiophenes. Positive methods of determination are used instead of methods involving determination by difference at a point when the sulphur content of the distillate is high and determination of total sulphur correspondingly less accurate. By this scheme more groups of sulphur compounds are directly determined and residual sulphur, i.e., difference between total sulphur and summation of the groups of sulphur independently determined, is reduced to a minimum. A distinction in properties exists between aliphatic and aromatic sulphides and the latter are accordingly placed in the thiophene group. It is pointed out that this scheme of analysis is strictly only applicable to straight-run distillates of the gasoline range. But useful results may be obtained on cracked distillates in this boiling range, equally on kerosines, if the limitations of the system be borne in mind. Certain difficulties arise due to presence of aromatic sulphur compounds in which the reactivity of the sulphur atom is changed by long carbon chains or heavy radicals. For instance, aromatic mercaptans readily oxidize to disulphides and these tend to polymerize. With increase of carbon–sulphur ratio, the sulphur compounds behave less like the types involved and resemble more closely the hydrocarbons from which they are derived. This report stresses need for further research in this particular field. H. B. M.

371. **Patent on Chemistry and Physics.** P. T. Tarnoski. U.S.P. 2,269,134, 6.1.42. Appl. 2.6.39. Preparation of a de-salting and demulsifying compound for treating crude petroleum consisting of a ketone body and a sulphonated body, both mutually soluble in water and petroleum. H. B. M.

Gas, Diesel, and Fuel Oils.

372.* **Effect of Type of Fuel on Engine Output.** Anon. *Gas Oil Power*, November 1941, **36** (434), 245.—Tests have been carried out with various fuels in a 6-cylinder commercial vehicle diesel engine of the pre-combustion chamber type developing 90 B.H.P. at a normal speed of 2400 r.p.m. The fuels used were (*a*) Kogasin from Fischer–Tropsch process, cetane number 86·5, (*b*) cracked gas-oil, cetane number 35, (*c*) 17·5% "*a*" + 82·5% "*b*," cetane number 43, (*d*) synthetic fuel oil, cetane number 46·5, (*e*) medium oil from lignite, cetane number 32, (*f*) gas-oil from lignite, cetane number 48·5, (*g*) 5% lubricating oil, 95% petrol, cetane number 29·5.

A curve gives power output based on engine speed and type of fuel used. Results indicated that fuel "*c*" gave a better output than fuel "*a*." This is explained by the fact that too short an ignition delay hinders the maximum possible mixing of air and fuel and the satisfactory progress of combustion. The tests show that for each fuel the most favourable conditions during the early part of the injection period have to be sought.

The author concludes that it is not economic to use fuel of very high cetane number, nor is the use of such fuels accompanied by better engine performance. D. L. S.

373.* Army Specifications Call for Three Basic Diesel Fuels. Anon. *Oil Gas J.*, 13.11.41, **40** (27), 27.—Army specifications for fuel for high-speed diesel engines have been revised, providing for three basic types of product.

These products must have minimum cetane numbers ranging from 45 to 50.

D. L. S.

374. Patents on Gas, Diesel, and Fuel Oils. R. S. George, G. S. Crandall, E. M. Nygaard, and D. E. Badertscher. U.S.P. 2,266,021, 16.12.41. Appl. 4.6.40. Addition to diesel fuel of a compound having the general formula R·CX·SNO in which R represents a radical selected from the group consisting of alkyl, alkaryl, aryl, and aralkyl radicals, and X is selected from the group consisting of oxygen and sulphur The compound is added in sufficient quantity to decrease the ignition-delay period.

L. N. Leum. U.S.P. 2,266,776, 23.12.41. Appl. 24.9.38. Preparation of a compression ignition fuel consisting of a fuel oil having an initial boiling point of at least 300° F. and an organic borine–amine addition compound in sufficient quantity substantially to increase the cetane number of the fuel. The structure of the borine compound is such that the boron atom is directly attached to a carbon atom only singly bonded to other atoms.

M. T. Kendall. U.S.P. 2,267,109, 23.12.41. Appl. 3.6.39. Method of treating a petroleum distillate fraction boiling approximately within the range 400–750° F. in order to stabilize it and inhibit increase in residual carbon content. The distillate is subjected not more than 72 hrs. after it has been distilled from the crude petroleum to contact with fresh unused aqueous caustic soda solution. In this way a stable diesel fuel is produced.

L. N. Leum. U.S.P. 2,267,701, 23.12.41. Appl. 5.4.41. Preparation of a compression ignition fuel consisting of fuel oil having an initial boiling point of at least 300° F. and an organic borine, the latter in sufficient quantity substantially to increase the cetane number of the fuel.

G. H. Cloud. U.S.P. 2,268,382, 30.12.41. Appl. 21.7.38. Manufacture of a fuel for compression-ignition engines of the diesel type consisting essentially of a hydrocarbon fuel and about 1–5% of an organic compound containing a thiocarboxylic acid radical. The addition compound imparts better ignition qualities to the fuel.

G. H. Cloud and L. A. Mikeska. U.S.P. 2,268,384, 30.12.41. Appl. 29.1.41. Preparation of a fuel for compression-ignition engines of the diesel type consisting essentially of a hydrocarbon fuel and a small amount of an organic compound containing an active thiocarboxylic radical and nitrogen. H. B. M.

Lubricants and Lubrication.

375.* Testing of Heavy-Duty Motor Oils. H. C. Mougey and J. A. Moller. *Nat. Petrol. News*, 10.12.41, **33** (50), R. 387.—Data from a series of tests carried out by a modification of the 67-hour Chevrolet Varnish Test are presented. It is concluded that the test gives a reproducible behaviour pattern for a series of standard oils which may be correlated with service behaviour. A standard is thus obtained for the examination of unknown oils and as a basis for specification. Other tests are required to assess resistance to ring and valve sticking and carbon formation. The effects of inhibiting agents added to the oil or derived from the fuels and the air/fuel ratio are discussed. H. G.

376. Patents on Lubricants and Lubrication. Standard Oil Development Co. E.P. 542,834, 29.1.42. Appl. 30.8.39. Method of decreasing corrosion of a metal in contact with a hydrocarbon lubricant by adding to the lubricant a small amount of an organic peroxide having a ring structure and which is of sufficient stability to remain substantially unchanged in a lubricant at temperatures up to 212° F.

A. Lazar and P. M. Ruedrich. U.S.P. 2,266,325, 16.12.41. Appl. 21.2.38. Preparation of a lubricant for internal combustion engines which includes a body of mineral oil containing an active oxidation and corrosion inhibitor. The main constituent of the inhibitor is taken from the group consisting of calcium sulphonate, barium sulphonate, and strontium sulphonate. The lubricant is substantially free from metal salts.

W. A. Smith. U.S.P. 2,267,142, 23.12.41. Appl. 10.3.38. Preparation of a lubricant consisting of a petroleum lubricating oil and a relatively small amount of quinhydrone. The resulting composition is suitable for use in internal combustion engines and has increased resistance to sludging in the crankcase, greater colour stability, and greater resistance to decomposition.

F. R. Moser and D. R. Nijk. U.S.P. 2,267,337, 23.12.41. Appl. 29.8.36. Preparation of an extreme pressure lubricant consisting of a mineral lubricating oil and from 1 to 10% of a polyphenyl substituted methane having at least one hydroxyl-containing radical with not more than one carbon atom between the hydroxyl group and the ring.

W. A. Whittier. U.S.P. 2,268,232, 30.12.41. Appl. 23.12.39. Preparation of a lubricant by reacting phosphorus containing material selected from the group consisting of phosphorus tri-halide, phosphorus sesqui-sulphide, phosphorus tri-oxide, phosphine, and elemental phosphorus with sulphur halide, and reacting the product with fatty body.

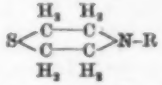
E. W. Adams and L. C. Brunstrum. U.S.P. 2,268,234, 30.12.41. Appl. 5.10.40. Preparation of a lubricant capable of forming an invert emulsion with water and consisting of 0·25–5% of an ester of a high molecular weight fatty acid having at least one hydroxyl group, 5–45% of an inert substantially non-abrasive finely divided solid material, and 50–94·75% of a lubricating oil.

E. Lieber. U.S.P. 2,268,409, 30.12.41. Appl. 20.9.38. Preparation of a lubricant consisting of a mineral oil and a small amount of a condensation product of a polycarboxylic acid halide and a petroleum oil fraction.

G. M. McNulty and J. C. Zimmer. U.S.P. 2,268,608, 6.1.42. Appl. 5.12.39. Preparation of a lubricant which includes an active halogen in a form normally corrosive to metals but capable of greatly increasing the load-carrying capacity of the lubricant, together with a small amount of an oil-soluble cyclo-aliphatic amine having a p_{KH} value greater than 7·0.

L. A. Hamilton, E. W. Fuller, and H. G. Berger. U.S.P. 2,269,265, 6.1.42. Appl. 14.12.39. Preparation of a refined viscous petroleum product consisting of a refined viscous petroleum fraction, normally subject to deterioration under conditions of oxidation, and a minor proportion of the reaction product obtained by reacting an *N*-substituted dialkyl aromatic amine with a halide of sulphur. Deterioration of the petroleum fractions is thus retarded.

R. C. Moran, D. E. Badertscher, and H. G. Berger. U.S.P. 2,269,282, 6.1.42. Appl. 31.5.39. Preparation of an improved mineral oil composition consisting of a viscous mineral oil fraction and a minor proportion of a compound of the general formula



in which R represents a radical selected from the group consisting of alkyl, aryl and alkaryl hydrocarbons. The addition agent is incorporated to inhibit the deleterious effects of oxidation on the oil.

V. A. Salim. U.S.P. 2,269,485, 13.1.42 Appl. 9.1.40. Conversion of asphaltic hydrocarbons to lubricating oil by bringing them into momentary contact with a body of molten metal maintained at a temperature between 450 and 550° C. The asphaltic hydrocarbon will thus be brought to a temperature between 275 and 375° C. The

resulting converted products are brought to this temperature by further contact with the molten metal by volatilization and atomization in a concurrent flow of both volatilized and non-volatilized portions. Steam is so adjusted that substantially no converted or unconverted asphaltic hydrocarbon is left in contact with the molten metal for longer than the desired momentary contact.

H. E. Johnson. U.S.P. 2,269,720, 13.1.42. Appl. 3.3.39. Preparation of a lubricant comprising in combination petroleum jelly and candelilla wax as the major constituent.

E. Lieber. U.S.P. 2,270,062, 13.1.42. Appl. 14.12.38. Preparation of a composition consisting of a hydrocarbon oil normally having a high pour-point and a small amount of an oil-soluble pour-depressing condensation product of one mol. of a condensible cyclic compound.

J. O. Clayton and B. B. Farrington. U.S.P. 2,270,113, 13.1.42. Appl. 10.6.40. Preparation of a liquid compounded hydrocarbon oil containing a metal salt of an organic acid in sufficient amount substantially to increase the corrosivity of the oil, and a corrosion inhibitor comprising an ester containing an amine substituent.

E. W. Adams, L. C. Brunstrum, and A. W. Weitkamp. U.S.P. 2,270,241, 20.1.42. Appl. 30.10.40. Preparation of a lubricant consisting of a lubricating oil, a metal salt of a carboxylic acid in an amount in excess of that which would be soluble in the oil, and a phosphatidic material in an amount sufficient to render the salt soluble in the oil.

E. Lieber, U.S.P. 2,270,319, 20.1.42. Appl. 16.7.40. Preparation of a lubricant consisting essentially of a waxy lubricating oil and not more than 5% of tall oil.

R. F. Bergstrom and E. E. Phillips. U.S.P. 2,270,577, 20.1.42. Appl. 31.5.40. Preparation of lubricating oil suitable for use in internal combustion engines and containing 0·25% to 5·0% of a sulphonate salt and an arylamine having anti-oxidant properties in an amount not less than one-sixth of the salt content. The sulphonate is oil soluble, free of free-acid, and combines a petroleum sulphonic acid with a polyvalent metal, which forms an oxide which is not readily converted to other oxides under conditions of crankcase lubrication.

U. B. Bray. U.S.P. 2,270,620, 20.1.42. Appl. 2.8.37. Production of lubricants by oxidizing a highly refined paraffinic type lubricating oil to produce in the oil reaction products including petroleum acids. A calcium compound is added to the resultant mixture to react with the saponifiable materials and the whole filtered. The resultant soap–oil solution is added to a naphthenic type lubricating oil to yield about 0·8–3·0% of total soap in the final lubricating oil composition. H. B. M.

Asphalt and Bitumen.

377. Patents on Asphalt and Bitumen. F. Dijkstra. U.S.P. 2,268,810, 6.1.42. Appl. 2.3.40. Addition to an asphalt of a sufficient amount of solid paraffin wax materially to increase its water repellancy and to give it a wax content of 2–10%. The resultant product is combined with water and an aggregate containing clay and used for soil stabilization purposes.

H. S. Goodwin and H. D. Winters. U.S.P. 2,270,047, 13.1.42. Appl. 30.12.39. Impregnation of asbestos cement board with a liquid saturant consisting of an asphalt having a melting point of 140–185° F., and 60–65% of a solvent naphtha having an A.P.I. gravity of 28–48° and a kauri butanol solvent power of at least 53. H. B. M.

Special Products.

378.* War Use of Gaseous Products from Cracked Oil. A. G. Arend. *Petrol. Times*, 13.12.41, **45** (1158), 720.—This article discusses the use of gaseous products obtained by cracking mineral seal or solar oil as a fuel for airships.

In the Graf Zeppelin, instead of only one gas being used provision was made for the introduction of a second gas to afford a certain measure of flexibility after the first gas had been exhausted.

Normal runs were made with Blau gas which was followed by Pyrofax gas, whilst at certain stages of the flight a mixture of methane and ethane was utilized.

In preparing Blau gas the oil is cracked at 600° to 700° C., and the butane, *iso*butane, and ethane are liquefied. Some of the methane and practically all the ethylene are dissolved in the liquefied gas, which is stored in steel cylinders at 100 atmos. pressure.

When released from the cylinders, the liquid evaporates to a gaseous product of about the same density as air.

Pyrofax, which was substituted after supplies of Blau gas had been exhausted, consisted of propane containing 2% butane, which was mixed with some 36·8% hydrogen to give a gas of the requisite specific gravity. The third mixture—methane and ethane—also had a density similar to that of air.

Since these gaseous fuels had densities comparable with that of air, their consumption did not alter the total weight of the airship, since they were replaced with air without making any appreciable difference to the buoyancy. D. L. S.

379. Patent on Special Products. E. M. Hattox. U.S.P. 2,270,052, 13.1.42. Appl. 29.12.38. Production of polymers of *iso*butylene not higher in molecular weight than tetra*iso*butylene by contacting di-*iso*butylene with anhydrous ferric chloride at a temperature between 150 and 300° F. H. B. M.

Detonation and Engines.

380.* New C.F.R. Road Test Technique Proves its Value in 1941 Programme. Anon. *Nat. Petrol. News*, 26.11.41, **33** (48), R. 381.—An abstract of a report by D. P. Barnard to A.P.I. refining session 7.11.41.

The new "border-line" technique for the determination of road octane values in terms of engine speed has been further developed during the 1941 tests and has confirmed earlier indications of its value. The latest results emphasize that single octane ratings cannot accurately evaluate the ignition quality of a fuel. H. G.

381.* 1941 C.F.R. Road Detonation Tests. J. M. Campbell, R. J. Greenshields, W. M. Holaday, and C. B. Veal. *Refiner*, November 1941, **20** (11), 499–504. *Paper Presented before American Petroleum Institute.*—During the past year the Co-operative Fuel Research Committee has continued its investigation of the knocking characteristics of fuels and engines in actual service. The centralized road knock tests made at San Bernardino more than a year ago resulted in the development of various road-test procedures. At the same time the tests supplied data illustrative of certain new principles, which appeared to have useful application as a means of expressing some of the engineering relationships between fuels and engines. The data obtained at that time, however, although valuable and suggestive, were not considered sufficiently extensive to warrant unqualified recommendation of these procedures and methods of analysis without further experience by individual laboratories. Accordingly, the programme carried out during the past year has been designed to test these procedures and methods of analysis, and to obtain more definite information with regard to their limitations as indicated by more extensive data.

The 1941 road detonation programme was divided into sections, as follows: (1) Ignition-timing relationships. (2) Control fuel tests. (3) Procedure evaluation. (4) Survey of characteristics of commercial gasoline. (5) Survey of octane number requirements of 1940 and 1941 cars, with particular attention to Chevrolet, Ford, and Plymouth models.

All items except the last one are discussed in detail, item 5 being briefly discussed.

On account of large variations in octane-number requirements among different cars of the same make—due to differences in ignition-timing, combustion-chamber deposit, and other causes—and on account of variations in commercial gasolines, it has been necessary to use statistical methods of analysis in the appraisal of fuel and engine

relationships. These methods of analysis have been applied in a number of ways, and have proved very useful. For this reason, the continuance of co-operative activity in compiling current statistical information annually on fuels and car requirements is recommended. A. H. N.

Coal and Shale.

382. Creosote in Diesel Fuels. Anon. *Chem. Tr. J.*, 19.12.41, **109** (2848), 307.—This is a short summary of a paper read at a meeting of the Manchester and District Junior Gas Association. At the outbreak of war the Halifax Transport Dept. decided to put their whole fleet of buses on a creosote–fuel oil mixture.

In making the blend the petroleum fuel is run into a tank, followed by the correct quantity of creosote: The mixture is allowed to stand for 24 hrs., and then put through a centrifuge running at 7000 r.p.m. and passing 350 g.p.h. It was found necessary to use a washed creosote to reduce deposition of sludge on blending.

Bench tests gave fairly uniform figures and confirmed the results obtained on the road.

The creosote used in these tests showed sp. gr. at 60° F. 0·943, open flash 170° F., closed flash 150° F., distillation I.B.P. 180° C., 50% to 230° C., 90% to 336° C., phenols not over 4% vol.

Some individual buses are claimed to have completed 60,000 miles without trouble. D. L. S.

Economics and Statistics.

383. Coal, Petroleum, Natural Gas, and Electricity in the United States, 1929–40. J. R. Bradley. *U.S. Bur. Mines. Information Circular*, No. 7189, December 1941.—There are four primary sources of fuel and power: coal, petroleum, natural gas, and water power. This report is a survey of the extent of these sources of energy in the United States and covers the period 1929 to 1941. It is to be noted that the United States is responsible for one-third of the world's coal output, practically two-thirds of the petroleum produced, 89% of natural gas marketed, and 23% of developed water power. The annual U.S. production of all forms of energy in terms of coal is about 1000 millions tons, and it is stated that even without opening new mines, drilling new oil wells, or harnessing additional water resources, the annual output of fuel and power could be substantially increased. Productive capacity during the period under review was estimated at about one-half the total world output of fuel and power. It is natural that the primary sources of fuel and power should be closely connected with major industrial developments; in this way coal (as coke) is essential to the metallurgical industries; hydroelectricity is similarly linked with electro-chemical and electro-metallurgical industries; petroleum has its obvious place in power and transport services and has been responsible for evolution of the internal combustion engine and all it has meant in the last few decades. It is conceded that coal still remains the dominant source of power, but is in point of fact losing ground to competitive fuels and water power. This is emphasized by production figures of bituminous coal (including lignite) which declined from 535 million tons in 1929 to 393 million tons in 1939. By contrast crude oil production increased from around 1000 million brl. in 1929 to about 1265 million brl. in 1939, an increase of over 25%. Similarly, natural gas production showed an increase of 29% over the same period and capacity of electrical generating plants increased 27%. The report includes full statistical data and graphs in support of these conclusions. H. B. M.

BOOK REVIEW.

Printing Inks, their Chemistry and Technology. By Carleton Ellis. Reinhold Publishing Corporation, New York. 1940. Pp. 560. Price 42*s*.

The subject of printing inks is one of considerable importance in everyday life and in these days ink may justly be considered a munition of war. Printing inks have a special interest for the petroleum technologist because so many petroleum products are used in their manufacture and application. Thus, oils of the lubricating and cylinder oil ranges, bitumens and residuals, petrolatum and waxes enter into their composition, especially in the case of the news inks. Kerosine and lighter petroleum products are extensively used as solvents and reducers and for cleaning printing machinery. Probably about two-thirds of the materials used in ink-manufacture in this country are of petroleum origin.

The volume on printing inks here reviewed is a very welcome contribution to the literature of the subject, particularly since, as the author remarks in his preface, there are so few books available and these are generally not of recent date. The literature on printing inks (apart from books), is, however, quite extensive and, as would be expected in a work by Carleton Ellis, the references are very numerous, more than two thousand being quoted.

The early chapters are introductory. In the first an excellent description of printing methods and processes is given, and this is followed by a discussion of inks divided according to their uses in typographic, intaglio, and planographic printing. A short chapter follows on the history of printing inks. Vehicles, driers, modifiers, and pigments (including carbon-black, the most important of all) are discussed in turn and then the three main classes of ink are treated in more detail.

Chapter 8, which deals with mineral-oil and quick-drying typographic inks describes the uses of asphalts and petroleum oils in inks intended to dry by absorption. It would, however, be difficult to get much practical guidance in the selection of a petroleum oil for use in, say, news-inks, from the information in this chapter.

Several chapters deal with inks of special types and for particular purposes and give a very interesting resumé of the materials used for printing on a variety of surfaces as diverse as fruit and meat, glass and metal.

"Printing ink problems" is the title of a chapter which includes discussion of a number of interesting subjects, such as storage, offset, and odour. A section on press-room problems includes some formulæ for roller and general cleaner fluids—for example "petroleum naphtha with 10% petroleum" and "80% petroleum naphtha, 15% xylene, and 5% petroleum." The use of the word "petroleum" in this way by such a well-known writer on petroleum chemistry is a little surprising; it is probably due to translation.

Various methods of testing inks are described in Chapter 17, and the final chapter discusses paper for printing purposes. The book is concluded by an excellent glossary and a very complete index.

This work is as comprehensive and detailed as are previous books by this author, and, while it is not a "practical guide to ink-making," it will be found a very valuable source of information and of ideas to all who are concerned in any way with the ink industry.

E. B. Evans.

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Geology and Development.

384.* Heart Mountain and South Fork Thrusts, Park County, Wyoming. W. G. Pierce. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 2021–2045.—Between Yellowstone National Park and the Big Horn Basin, the South Fork nappe with up to 3800 ft. of beds, mainly shales, of Sundance (Jurassic) to Cody (Cretaceous) age, including a recumbent anticline, has moved towards the south-east, being diverted from an easterly direction by the Rattlesnake anticline. When viewed over a stretch of several miles, the sole of thrusting is seen to undulate, and in the zone of fracture, sometimes only 2 ft. thick, quartz pebbles and boulders, before breaking, seem to have acted as "ball-bearings" upon which horizontal displacement was facilitated. Movement was completed before deposition of the last of the Wasatch sandstones which are terrestrial and contain a Lower Eocene fauna, including *Coryphodon*, *Eohippus*, *Heptodon*, *Homogalax*, and *Lambdotherium*.

The subsequent Heart Mountain thrusting, which took place near the close of the Lower Eocene, brought a fairly horizontal sheet of Ordovician to Mississippian rocks, up to 1300 ft. thick, a distance of 34 miles eastward. In Sunlight Basin the sole was subterranean, but elsewhere the thrust-sheet moved across an erosion surface, probably of low relief, upon such earlier structures as the large anticlines of the Rattlesnake and Pat O'Hara Mountains and the smaller Shoshone anticline. Pebbles in underlying conglomerates were shattered by the thrusting, and near Dead Indian Creek a 150-ft. limestone conglomerate, eroded from the advancing mass, was deposited in front of it, and finally over-ridden. The roots of the nappe are concealed, probably under the volcanics of the Absaroka Mountains. The "early basic breccia," Middle Eocene (?), was erupted from fissures and vents of irregular shape, commonly aligned along north-west–south-east zones of crustal weakness. Movement of the breccia is regarded as having tilted some limestone blocks near the vents. A. L.

385.* Post-Appalachian Faulting in Western Kentucky. R. Rhoades and A. J. Mistler. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 2046–2056.—The Devonian to Upper Carboniferous rocks in the Ohio, Tennessee, and Cumberland River regions of Western Kentucky are complexly faulted, especially near the Ohio River, where the major fractures continue for many miles and fault-blocks show displacements sometimes exceeding 1000 ft. The main blocks are crossed by a mosaic of smaller, usually vertical faults. A formerly continuous, unconsolidated cover of Upper Cretaceous—Tuscaloosa clayey gravels unconformably overlain by Ripley fine sand with argillaceous intercalations—and of Tertiary gravels furnish little clear evidence of fault-planes, although maps prepared under Jillson, who insisted that some of the faults were still active, show the Oakland fault cutting the Tuscaloosa. Roberts located Mesozoic and later faults by juxtaposition of Mississippian and Cretaceous and by high local dips in the Tuscaloosa. Slumping obscures most sections unless in recent cuts, but, from the latter, new evidence is drawn concerning intra-Tuscaloosa faults, down-throws of Ripley against Tuscaloosa, and probable throws of Tuscaloosa and Ripley against Mississippian residual chert and clay. Since the pre-Cretaceous surface was of slight relief, concealed faults may also be deduced from zones of sudden thickening in the Tuscaloosa, probably indicating movement connected with the intermittent development of the Mississippi embayment. Clay and pebble dykes up to 9½ ft. wide provide proof of earthquake vibrations though not necessarily due to movement of adjacent faults. These sedimentary dykes traverse the Pliocene (?) terrace gravels, but not those of Pleistocene age, have numerous off-shoots, and may be inclined at as much as 45°. A. L.

386.* Non-Marine Origin of Petroleum in North Shensi, and the Cretaceous of Szechuan, China. C. H. Pan. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 2058–2068.—The margins of the basin of North Shensi show Cambro-Ordovician limestones and a Permo-Carboniferous coal series. The filling of the central part is non-marine: Shihchienfên purplish-red sandstone, about 600 m. (Permian); Yenchang grey cross-bedded sandstone with plants, lamellibranchs, and fish-scales, about 1270 m. (Upper Triassic); Wayaopu coal-bearing beds, 850 m. (Rhaetic and Lias); Anting

red sandstone and argillaceous limestone with *Pholidophorus*, 80 m. (Upper Jurassic); Paoan red sandstone and shale, about 2000 m. (Cretaceous); reddish clay and loess (Upper Pliocene-Pleistocene). There are widely scattered, but minor, oil seeps from eight horizons, five in the Yenchang and three in the Wayaopu. As there is no intense folding or faulting the oil probably comes from lacustrine shales near the oil sands. It could not have migrated, without dissipation, from the deep Palæozoic marine beds under the thick sandstones and shales of the Shihchienfên series. Favourable structures seem rare. The oldest well at Yenchang has yielded 0·3 brl./day for 20 years. The greatest initial yield from a well was 34 brl./day, but this soon decreased to 1 brl.

In Szechuan province new industries are growing up and it is still hoped to find commercial oil on a small scale. The succession is: Feihsienkuan purple shale and thin limestones with *Pseudomonotis*, about 200 m. (Lower Triassic); Chialingchiang limestone and dolomite, containing foraminifera and lamellibranchs, about 600 m. (Middle to early Upper Triassic); Hsiangchi greyish coarse sandstone, dark shale, thin coals, about 500 m. (Lower Jurassic); Tzuliuching grey and red shale and sandstone, followed upwards by Chiating red beds with some black shale and thin limestones yielding the freshwater shells *Cyrena* and *Unio*, over 2000 m. (Cretaceous). Two seepages are known near anticlinal axes in red Tzuliuching, and thirty wells of about 70 m. have been drilled, two of which yielded 67 brl. before exhaustion. The source is probably in Tzuliuching limestone. There are also reports of oil-sands in the Chialingchiang and the Hsiangchi formations of the Fushun–Loshan area, where the oil presumably originates from the marine Triassic.

North Shensi and Szechuan both produce salt, and the connate water of the former field is generally saline, so that concentration to a salinity of 3000 p.p.m. may have allowed anærobic bacteria to transform organic remains into petroleum. In fresh waters only coal and oil-shale may be produced, since ordinary bacterial decay does not remove a sufficient amount of the tissues of plants or appreciably act on fats. A secondary consideration is that organic matter in lacustrine sediments may often exceed that of marine deposits. A. L.

387.* Graywackes and the Petrology of the Bradford Oilfield, Pennsylvania. P. D. Krynine. *Bull. Amer. Ass. Petrol. Geol.*, November 1941, **25** (11), 2071–2074.—It is pointed out that the Third Bradford Sand (Upper Devonian) was deposited as a series of coalescing small deltas along a subsiding shoreline where rainfall may have been heavy, not as a delta like that of the Mississippi or like Fettke's two-lobed delta. A contrast is drawn between the greywackes of this deposit and the quartzose sandbars studied by P. A. Dickey in the Titusville quadrangle. It is emphasized that the clastic fragments in greywackes typically include rounded or angular pieces of other rocks such as shale, slate, sandstone, chert, quartzite, mica, iron ores, as in the Bradford greywacke, as well as basic and other igneous shards, in an argillaceous binding. Numerous references are given, including one, historically important, to C. F. Neumann's *Lehrbuch der Geognosie* (1850). A. L.

388.* Mississippian Formations [with Reef-Knolls] of Sacramento Mountains, New Mexico. L. R. Laudon and A. L. Bowsher. *Bull. Amer. Ass. Petrol. Geol.*, December 1941, **25** (12), 2107–2160, with Bibliography.—The Sacramento range runs south from the igneous peak of Sierra Blanca, in South Central New Mexico, and for the most part along it Mississippian limestones dip eastwards away from a western fault-scarp. They rest unconformably on the Percha shales (Devonian), but are in no place in contact with the basal Percha silts, or with the underlying Niagaran (Silurian) limestone. The unconformity is marked by an oxidized zone with phosphatic concretions and some fish-teeth. The Mississippian is overlain, with sharp unconformity, by Pennsylvanian, and in hollows of the surface of contact there are chert conglomerates.

In the Lower Carboniferous the species comprised in Kinderhook and Osage faunas respectively are almost entirely different, though ancestors of specialized Osage forms occur in the earlier formation. The Osage yields diversified crinoids, including highly adapted types like *Eutrochocrinus christyi* and *Uperocrinus pyriformis*, and ponderous branchiopods like *Spirifer rowleyi* and *S. grimesi*. From the Appalachians

to the western United States, following an erosional break, beds of Osage age overlap widely upon older beds, so that the Kinderhook has a definite upper limit.

The Caballero formation of the Sacramento Mountains belongs to the Kinderhook, and consists of nodular, grey, shaly limestone, about 50 ft. thick at the type section in Deadman Canyon. Re-worked Caballero sediments appear in the base of the Alamogordo, which, together with the succeeding Arcente and Dona Ana members, constitutes the Lake Valley formation of Osage age. Characteristically the Arcente is of soft grey siltstone and shale, while the Dona Ana is hard crinoidal limestone with chert and small bioherms. The Alamogordo is more varied. In the type section it begins with *Taonurus* silts, about 25 ft., and these are followed by black cherty limestone, 17 ft., which expands laterally into mainly bioherm (reef-knoll) accumulations with maximum thickness, as in the San Andreas Canyon, of about 200 ft. The bioherm hummocks have fairly flat bases, from about 1 ft. in diameter to 1 mile across, and towards their outer margins, where fossils increase in number, definite bedding can often be recognized, with dips of as much as 40° on the west sides, which seem to have faced prevailing currents or waves. Away from the exposed side the bioherm material fingers into fine-bedded grey crinoid limestone, which thins and passes underneath a green crinoidal sand. Limestone conglomerates also occur close to the bioherms, but in at present unpredictable relations, and frequently show relatively angular bits of the underlying facies enclosed in the grey or green crinoidal rock. Farther back, on the sheltered side of the reef-knolls, are bluish-grey marls, deposited in a lagoonal environment, and containing the unbroken crinoids for which South-western New Mexico is famous. This bed may be only a few feet thick. Above it, upper grey crinoidal beds, though only poorly represented to seaward of the bioherms, fill up the protected—and possibly relatively warm—basins behind them.

Thanks to the reef-knolls, the upper boundary of the Alamogordo is irregular, but there is no fragmentation or evidence of overlap at the base of the Arcente silts, 100 ft. thick in Deadman Canyon, albeit these vary from 0 ft. over the large San Andreas knoll to 155 ft. less than a mile away from it. The only sign of disconformity reported is in San Andres Canyon, of the San Andres range, west of the one under discussion, where red oxidized streaks and broken shells occur above a bioherm. There is no great difference between the faunas of the Arcente silts and the succeeding Dona Ana coarsely crystalline crinoidal limestone, 55 ft. in type section. They are equal in age to the Lower Burlington of the higher part of the Mississippi valley, while the Alamogordo is principally pre-Burlington.

The Mississippian, with the exception of the Caballero, becomes attenuated towards the south end of the Sacramento Mountains. A. L.

389.* Experiments with Lights, Shadows, and Contours, and the Resulting Shadowgraphic Contour Maps. R. F. Imbt. *Bull. Amer. Ass. Petrol. Geol.*, December 1941, **25** (12), 2161–2169, with Bibliography.—Contours date back to Cruquius, 1728, in Holland, and hachures, replacing cruder hatchings, to Muller, 1788. Of later development were graduated tints and relief-shading, the latter seen to advantage in French military maps, in which a dual source of light is employed, and in the United States Geological Survey maps of Lake Lahontan, 1885, and Lake Bonneville, 1890. Owing to cost of lithographing, the United States shelved this technique till 1921, when photolithography at last permitted the economical reproduction of the most delicate shades. Light and shadow have subsequently been applied as if the mapped areas lay under a 4 p.m. sun in late summer.

In representation of geological structure little use has been made of shading, though it would render maps more intelligible to administrators, commissions, juries, students, and even geologists. Plates are provided of five subsurface maps, on which Robert Imbt has added, by hand, gradational shadows to bring out, at a glance, folding and throw of faults. The following rules are suggested: (1) Contours and other details must not be obscured; (2) lighting must be from a northerly direction—the United States Geological Survey and Engineering Corps restrict themselves to a north-westerly light in their "shaded topographic" and "pictorial relief" maps—but in geological work it is desirable to have the direction of lighting at right angles to the predominating structural axis; (3) the best elevation of the source of light is about 30° above the plane of the map; (4) deep shading should be confined to surfaces sloping away from the source of light, and must never transgress the axis of a syncline;

(5) the downthrow side of a fault is always shaded, but the shadow is softened if the downthrow side is towards the light; (6) the lighting effects are those to be expected from a polished surface, on which contours have been plotted; (7) to eliminate the range-finding ability of the two eyes, it is well to observe the map with only one. A. L.

390.* Deposition of Free Oil by Sediments Settling in Sea-Water. O. A. Poirier and G. A. Thiel. *Bull. Amer. Ass. Petrol. Geol.*, December 1941, **25** (12), 2170–2180. Specimens of Decorah (Ordovician) sericitic shale, Blue Earth quartzose and argillaceous silt, freshwater calcium carbonate marl, bentonite rich in montmorillonite, diatomaceous earth of hydrous or opaline silca, oil-shale, humus soil with high organic content and low sp. gr. when dry, silt made up of quartz and calcium carbonate, calcareous and sericitic shale, silty sand mainly of quartz and sericite, and kaolin from granite gneiss, were crushed and screened to two sizes—$\frac{1}{4}$–$\frac{1}{8}$ mm. and less than $\frac{1}{4}$ mm. 1-gm. samples were then deflocculated, by means of a soil-dispersion machine, for 5, 10, or 15 mins., in mixtures of 2·5 c.c. Mid-Continent crude oil, of 32·7° Be at 60° F., emulsified in 200 c.c. artificial sea-water. High concentrations of sediment were avoided, since particles, if too numerous, increase the viscosity, and may set up vertical currents which carry oil upwards.

Humus and oil-shale, which are rich in organic particles, settled very small quantities of oil, which, on microscopic examination, was seen to assume laminar rather than globular forms, due to organic acids lowering oil-water interfacial tension (Traube's rule). In the other cases varying quantities of oil-globules were carried down by the weight of adhering mineral grains. Farenwald has shown that the film of oil adsorbed by a mineral surface is thickest on galena and thinnest on quartz. Quartz and calcite do, however, stick to oil-globules, and any electrical charges on oil or mineral particles, which might cause mutual repulsion, are neutralized by the NaCl electrolyte. Irrespective of mineral composition, fine-grained sediments, with the possible exception of bentonite, carry down most oil. Large fragments of mineral may fail to adhere to globules, because of too much weight per unit of attracting force. Again, in certain circumstances, lowered surface tension may allow the buoyancy of the oil-globule to exceed its internal coherence, so that part of it breaks away. A. L.

391.* Trace-Slip Faults. R. H. Beckwith. *Bull. Amer. Ass. Petrol. Geol.*, December 1941, **25** (12), 2181–2193.—Trace-slip faults are those in which the movement is parallel with the trace of strata or other planar elements upon the fault-plane. Following erosion, such faults may leave no evidence in the form of offset (side-stepping), omission, or repetition of beds. Even where the fault-plane is visible and shows slickensides, the latter may indicate only the direction of the last, and not of the major movement. The study of this kind of oblique dip-faulting is important in interpreting displacements which cross anticlines in the Rocky Mountain oil region—*e.g.*, in the Laramie Basin, Wyoming. One example is of a thrust dipping west at 40° in an overfolded anticline, and apparently fading out, while what looks like a normal east–west fault crosses the adjacent syncline. Actually the two are the same fault due to one oblique movement, and the connection between the two parts is obscured by the trace-slip factor. Intersecting thrust and tear-faults, if the displacement of both is in the same oblique direction, even though of different ages, need not appreciably interrupt each other's outcrops.

Some anticlines, like those of Rock Creek and Clay Basin Dome, are marginal folds formed, at least in part, by compression of Cretaceous beds in front of rising and advancing nappes of older rocks, but others, in synclinal basins far from travelled nappes, may actually overlie thrusts initiated in underlying pre-Cambrian crystalline rocks capable of transmitting stress from a distance. Such thrusts increase in dip and die out towards the surface, and trace-slip faulting in this kind of structure, parallel either to the anticlinal axis or to beds on one or other side of it, produces the appearance of ordinary dip faulting with great variation of throw, or even of pivotal faulting with opposite throws in different directions. If the oblique nature of the displacement is not recognized it may be difficult to correlate producing zones on the flanks of the faulted anticline. Sections on transparent paper should be

prepared for each side of these faults, and the two diagrams may then be made to coincide by trial movements which can often be simplified to one oblique adjustment. A. L.

392. Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma. Part 4. Townships 24 and 25 North, Ranges 10 and 11 East. L. E. Kennedy, J. D. McClure, H. D. Jenkins, and N. W. Bass. *U.S. Dept. Inter., Geol. Surv. Bull.* 900D, 1940, 131–171.—The area dealt with in East Central Osage County, Oklahoma, is a few miles south-west of Bartlesville. About 2350 wells have been drilled, and some dating from 1905 are still producing. Only gas is obtained from the Siliceous Lime (Ordovician), the upper part of which is a crystalline dolomite with chert, and this gas is concentrated in the tops of domes. The Bartlesville sand, laid down as beach deposits in the early Pennsylvanian, occurs at depths of 1500–2100 ft., and is the chief reservoir, the distribution of oil depending on stratigraphical factors rather than on structural attitude. Contouring of the Oswego Lime, about 400 ft. above the Bartlesville, seldom shows closure of over 100 ft. New oil localities should be revealed by prospecting, and much oil should also be obtained by repressuring the Pennsylvanian sands with gas or water, as has already been done, with gas, in the Bartlesville of the Avant field. A. L.

393. Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma. Part 5. Townships 26 and 27 North, Ranges 10 and 11 East. L. E. Kennedy, W. E. Shamblin, O. Leatherock, and N. W. Bass. *U.S. Dept. Inter., Geol. Surv. Bull.* 900E, 1940, 173–208.—The area lies in North-eastern Osage County, about 3½ miles west of Bartlesville. The Siliceous Lime (Ordovician), eroded to different depths on domes, sometimes with nearly the whole thickness of 1000 ft. removed, yields only gas, though in Southern Osage County it yields oil. The most productive zones are in the sub-angular quartz sands of the Bartlesville (early Pennsylvanian) irrespective of structure, and in the weathered Mississippi cherts and the coarse quartzose Burgess sand of the Mississippian–Pennsylvanian unconformity, where the oil occurs usually low on the flanks of domes and in synclines. Closures are small, and the regional dip is westward at about 30 ft./ml. There are a few localities where drilling may encounter new oil- and gas-pools. A. L.

394.* Ohio–Clayton Pool in Perry County Best Recent Ohio Discovery. Anon. *Oil Gas J.*, 29.1.42, **40** (38), 187.—At Clayton in South-east Ohio forty-five producers were drilled to the Clinton sand, extending the pool to 5 sq. ml. The average production of these wells is 152 brl./day, as compared with 14 brl./day for the whole State.

East of Thornville, in Perry County, another Clinton oil-pool was opened. Extensions were made to the Bush Creek gas-pool.

In Central Ohio the Newark gas-field seems to have reached its peak. Water-flooding was undertaken in the Berea sand in the Lodi field.

Numerous wildcats were drilled in the eastern part of the State, but, with one exception, the results did not seem to warrant further testing. G. D. H.

395.* Extensive Activity in Western Canada Seen for Coming Year. T. P. Sanders. *Oil Gas J.*, 19.2.42, **40** (41), 60.—Late last summer the first commercial producer was completed on the Twin River structure in Southern Alberta. 75 brl./day were produced during a ten-day test. Near by are three well-defined structures—Del Bonita, Ross Lake, and Spring Coulee. All these structures lie on the north-west flank of the Sweetgrass arch, and are local closures on anticlinal folds or noses. Del Bonita, Ross Lake, and Spring Coulee are on the Chalk Butte nose, while Twin River is on a parallel nose to the east, with the Madison apparently nearer the surface than on any other Canadian structure. The oil at Twin River is in the Madison, beneath the Ellis.

The four structures have been examined by geophysics and core-drilling as well as by other means. The first well on the Twin River structure gave oil, but went over to water mainly on acidization. The second well came in at 6,000,000 cu. ft. of gas/day with some oil. A third well was dry. While the fourth, and successful well was

being drilled, cores were examined carefully to ensure that bottom-water was not penetrated or other slips made. Acid treatment and cementation were carried out, and the well was completed as a pumper.

The reflection seismograph showed the apex of the structure at depth to be east of the apex of the surface structure, and the same condition exists at Del Bonita. Two tests have been drilled to inconclusive depths on the Del Bonita structure, one finding 1,500,000 cu. ft. of gas and 10 brl. of oil/day from the Madison at 5136 ft. The Madison is much deeper on the Ross Lake and Spring Coulee structures, which have been studied geophysically.

Three hundred miles to the north the Vermilion field is being developed. Eleven wells are producing from the Cretaceous at depths of about 1800 ft. G. D. H.

396.* Argentine Increased Oil Output during 1941. Anon. *Oil Wkly*, 9.2.42, **104** (10), 56.—During 1941 Argentine produced 22,015,138 brl. of oil, a rise of 6·8% above the 1940 figure. Comodoro Rivadavia, Mendoza, Plaza Huincul, and Salta yielded 15,718,000, 3,344,470, 1,071,318, and 1,880,015 brl. of oil, respectively. The Mendoza output rose by 33%.

Only 16,000,000,000 cu. ft. of gas were produced in 1940. G. D. H.

397.* Arkansas Discovery Opens Vast Region for Exploration. G. B. Nicholson. *Oil Wkly*, 16.2.42, **104** (11), 21.—A seemingly important discovery has been made recently at Midway, in Lafayette County, Arkansas, in a previously condemned area which is separated from other deep production by a fault, generally believed to mark the limits of Smackover lime production. Furthermore, the oil and gas discovered are free from sulphur, which is one of the objectionable points about the usual Smackover production.

A fault zone runs generally north-east near the Midway pool, continuing to Nevada and Ouachita counties before turning south-east. It may be connected with the Balcones–Mexia fault system. Wells drilled near the faults usually found low permeabilities. The Midway field, lying some distance north of the fault zone and apparently unconnected with it, appears, from reflection seismograph work, to be a dome. The Smackover formation has an upper oolitic lime zone of high porosity, a middle non-permeable zone, and a lower granular, porous zone. The discovery well encountered the Smackover at a depth of 6296 ft. The casing was perforated in the oolitic zone at 6340–6370 ft., and the well's initial flow was 80 brl./hour through a 20–64-in. choke, with a gas/oil ratio of 257. The lime has a porosity of 21% and a permeability of 500–700 millidarcys. The oil gravity is 35·5. A bottom-hole pressure of 2915 lb./in.^{2} and a temperature of 173° F. were recorded.

The structure may cover 5000 acres, and the results of core examination indicate reserves of 36,000 brl./acre for the oolitic zone. Two maps and an electric log are included. G. D. H.

398.* Texas–Louisiana Coastal Region Holds Many National Records. R. Reaves. *Oil Wkly*, 16.3.42, **105** (2), 33.—Excepting Texas itself, the Texas–Louisiana Gulf Coast has few rivals from the standpoint of reserves, yield to date, and current production. The reserves have risen steadily during the past few years to 3,864,587,000 brl., nearly one-fifth of the total current U.S.A. reserve. 181,937,594 brl. of oil were produced in 1941, as compared with 162,563,323 brl. in 1940. The 1941 output was third to Texas and California, and in that year the South Louisiana production exceeded that of the Texas sector of the coastal region for the first time. At the beginning of 1942 the daily output was 558,483 brl./day, a figure exceeded only by Texas and California.

Thirty-five new fields were discovered in 1941 as compared with thirty in 1940. Fifty-nine new producing horizons were found on known producing structures in 1941. South Louisiana leads all other areas by a wide margin in the number of deep producing fields and wells. It has thirty-two fields producing below 10,000 ft., while Texas has six fields flowing oil or distillate below that level. 800 of the world's 1133 10,000-ft. wells are in this region.

The most important recent discoveries are Bayou Sale, St. Gabriel, and Pine Prairie in Louisiana, and Oyster Bayou and Lake Creek in Texas. The largest recent extensions were at North-east Gibson and Old Ocean, while new sand bodies were opened

at West Bay, Venice, Gueydan, Erath, Chocolate Bayou, Hull, Dyersdale, Lucky, and North Markham.

The Wilcox trend was one of the most active, resulting in discoveries at Lake Creek and Magnolia.

Conroe is the largest of the Gulf Coast fields. Fields with reserves in excess of 100,000,000 brl. include Hastings, Old Ocean, Anahuac, Thompson, Friendswood, Conroe, Ville Platte, Lafitte, and Paradis. Six fields on the Texas Gulf Coast and one in South Louisiana have given over 75,000,000 brl. of oil to date. G. D. H.

399.* Texas Gulf Coast Field Development, Producing and Reserve Data by Fields. Anon. *Oil Wkly*, 16.3.42, **105** (2), 35.—The fields are arranged alphabetically according to counties, also arranged alphabetically, and the following data are given: discovery date, range of producing depths, producing formations, proved acreage, spacing, the total producing wells and the number flowing, the daily production, the production during 1941 and the total production to date, estimated reserves, the depth and formation reached in the deepest test, the gravity range of the oil and the number of rigs running. G. D. H.

400.* Louisiana Gulf Coast Field Development, Producing and Reserve Data by Fields. Anon. *Oil Wkly*, 16.3.42, **105** (2), 37.—The same types of data are given as for the Texas Gulf Coast, and the arrangement is the same as for that region. G. D. H.

401.* Wilcox Trend Play at Peak. K. H. Ferguson and S. R. Casey. *Oil Wkly*, 16.3.42, **105** (2), 41.—Prior to May 1937 Wilcox production in the Gulf Coastal area was confined to the Clay Creek and Kittrell salt domes, but the completion at that date of a well at Joe's Lake showed oil to occur commercially in Wilcox sand bodies, and that the Wilcox persisted down-dip. Along this Wilcox trend the Cockfield highs along the old Conroe trend offer excellent possibilities of new deep production. Most of these prospects have been drilled and found barren of commercial production in the Cockfield and Yegua, apparently due to insufficient closure. Wilcox production has been established on structures already producing from the Cockfield and Yegua.

A study of the geophysical data in Lavaca, Colorado, and De Witt counties reveals a series of long and more or less parallel faults, mostly strike-faults with closure on the down-dip side and of greatest amount in the Wilcox. There is a need to search for stratigraphical traps.

The reflection seismograph appears to be the most valuable geophysical instrument in the present search, with subsurface geology playing a major part in the exploration of the producing trends. There is evidence that the Wilcox is deltaic; correlation of sand from well to well is often impossible.

Investigation of the Wilcox trends calls for subsurface geological work, followed by geophysics to check any anomalies; the drilling procedure should be beyond reproach, with coring where possible and a search for new methods of detecting oil and gas, for in the Wilcox it is often difficult to distinguish an oil-sand from a water-sand by electrical logging. In this connection mud analysis, geochemical analysis, and fluorescence analysis seem to offer possibilities. G. D. H.

402.* Gulf Coast Oilfields, Salt Domes, and Prospects. Anon. *Oil Wkly*, 16.3.42, **105** (2), 59.—The following information is given, where possible, for the fields and prospects arranged alphabetically under alphabetically arranged counties or parishes: location, means of discovery, discovery well, structure, elevation, producing formations, proven acreage, cumulative production, estimated reserve, daily production, the number of producing wells and the number of rigs running on 1st January, 1942, gravity of the oil, data about the deepest test, oil outlet, principal leaseholders, and sundry remarks. G. D. H.

Geophysics.

403.* Present Status of Geophysics in Canada. Part I. A. A. Brant. *Trans. Canadian Inst. Mining and Met.*, January 1942, **45** (357), 45–65.—A general study of the chief geophysical methods is made in two parts of this paper. Historical development is sketched. The following are the chief geophysical exploration methods in common

usage, tabulated in approximate chronological sequence of practical development: (1) magnetic; (2) gravimetric; (3) electric; (4) seismic; (5) radioactive; (6) soil and gas analysis. Method (3) is subdivided into (A) self-potential, (B) resistivity (C) electromagnetic.

Methods 1, 2, 3B, 4, 5, and 6 are being used in petroleum exploration, with 2 and 4 being extensively applied and yielding highly satisfactory results; over 20% of wells thus spotted are producers.

Methods 1, 2, 3, and 4 have been attempted in various Precambrian regions. Method 1 has consistently yielded reliable data. Applications of 3A and 3B have met with only limited practical success. Method 3C has many field limitations, while 2 and 4 have been tried only a few times. These methods are discussed in the paper under the following headings: (1) physical basis of method; (2) instruments; (3) field procedure; (4) interpretation; (5) applications and limitations with field practice. Part I of the paper deals only with methods 1 and 2. The economics governing application of geophysics is briefly discussed.

Interpretation consists of finding the approximate location, extent, and nature of the rock bodies (*a*), structural occurrences (shears, faults) (*b*), bed-rock features (*c*), and topographic and overburden conditions (*d*), that cause the observed anomalies. Only (*a*) and (*b*) are of practical importance; consideration of (*c*) and (*d*) as a cause of anomalies is, however, obviously necessary. The process of interpretation occurs in two steps: (1) the location and breadth of the anomaly-producing bodies are found by breaking down the experimental profile curves into recognizable component parts due to bodies of known cross-sectional form; or by combining the values across known geometrically shaped bodies to give results similar to the field-observed. (2) To the various bodies a lithological or structural characteristic is assigned consistent with its physical properties as indicated by the geophysical results.

Step 1 can usually be carried out with some finality independent of 2—*i.e.*, the breadth and length of rock regions marked by contrasting physical properties can be established.

Step 2, practically, can only be carried out through geological correlation—*i.e.*, through a knowledge of the rocks present and their physical properties. Since the physical properties of a given rock may change laterally—*e.g.*, tuffs—and since two phases of the same rock may give the same geophysical results as two different rocks, it is clear that best correlation is obtained with outcrops and drill-holes in the area under survey—*i.e.*, geophysical methods serve best in geological interpolation This is why some of the most successful geophysical results in Precambrian areas have be obtained in tracing the extension of known geological conditions—*e.g.*, Buchans and Steep Rock. Reinterpretation of data in the light of subsequent drilling evidence is strongly urged. Similarly, a certain amount of drilling by geophysical parties is recommended. It is pointed out that the inverse problem to interpretation step 1 is, knowing the rock properties and general geological set-up, to calculate the geophysical anomalies for the various methods. This means that, if the rock properties and geology in a given area are even roughly known, the order of the geophysical anomalies to be expected in the field may be calculated, the most adaptable method or methods selected, and the detail, approximate cost, and time of survey required, determined before even going into the field. The accuracy of such determinations will increase with the definiteness with which knowledge of the rock properties, geology, topography, and drift conditions allow the geophysical problem to be postulated and working conditions to be evaluated. A. H. N.

404.* Present Status of Geophysics in Canada. Part II. A. A. Brant. *Trans. Canadian Inst. Mining and Met.*, February 1942, **45** (358), 66–87.—In the second part of this paper the remaining methods listed and not given in Part I are described under the several headings discussed (see preceding abstract). The use of more than one method in an area is mentioned and briefly discussed.

Generally, the following are the limitations of geophysical methods: (1) Any geophysical method is limited by the necessity for contrast in the given physical property for the rock materials present. If contrast in the physical property is lacking, the method is useless—*e.g.*, lack of sufficient radioactive contrast as regards many Precambrian regions. (2) All geophysical methods are limited by the fact

that the value measured at the surface is the resultant of conditions at and around the observation point. Hence, an interpreted geophysical picture can never be more than an idealized, simplified picture of a geological complexity. (3) All geophysical methods are limited by decrease in resolving power with the depth of the body of contrasting physical property. Hence, the deeper the body the greater volume it must have to create a given anomaly, and, by the same token, the greater is the effect of surface anomalous bodies compared to comparable bodies at depth. The result is, first, that the correction for the surface anomalies is important for most methods, and, second, that the presence of large irregular surface anomalies may, for practical purposes, eliminate the applicability of certain methods—*e.g.*, the torsion balance and high-frequency electromagnetic methods in the Precambrian; and seriously limit the applicability of others—*e.g.*, low-frequency electromagnetic, self-potential, and equi-potential methods. (4) As regards practical application, geophysical methods may be limited economically—*i.e.*, by their inability to yield geological information at the cost for which comparable information may be derived by other means. This limitation is important, for into it come factors of reliability, mobility, necessary personnel, etc. Gravimetric, seismic, and perhaps soil analysis methods are thus eliminated as regards general Precambrian applicability. (5) A further limitation is interpretation by which the physical picture is changed into a geological one. Factors limiting interpretation are the number of points of geological correlation, the extent to which theory approximates the field conditions, factor (3) above, and the personal equation of the geophysicist.

Finally, the following conclusions are reached: (1) In the light of the above limitations, 1, 2, 3, and 4, the magnetic and resistivity or ratiometric methods are the only ones which have general applicability in the Precambrian. For special problems which can be fairly accurately postulated, the other methods may prove applicable and extremely valuable from time to time. In view of 3, 4, and 5, magnetic methods should be, in general, more applicable and reliable. The magnetic method is, hence, the most generally applicable method for work in the Precambrian. (2) The most efficient use to which geophysics can be put in the Precambrian is determined by the above limitations, chiefly 4. For the problem considered, geophysics must present the most economical source of the necessary information. Hence, one of the chief applications of geophysics in the Precambrian should be the elimination of the barren sections of drift-covered areas; a second should be the tracing of known conditions into and under drift-covered areas. (3) The future of geophysics in Canada in the next years is bound up in the economic limitation 4. No great flurry of geophysical activity can, hence, be expected. The necessity for patient and scientific and more complete exploration of drift-covered areas should lead to gradually greater use of geophysics in closer co-operation with more detailed geological surveying. Magnetic methods will continue to be chiefly applied, with the electrical resistivity or ratiometer methods gaining in reliability due to better theoretical approximations of experimental conditions.

A. H. N.

Drilling.

405.* Drilling Records Permit Increase in Drilling-Rig Efficiency. H. F. Simons. *Oil Gas J.*, 22.1.42, **40** (37), 29–30.—The record of a well made during drilling is for the most part designed for the producing department rather than for the use of the drilling-rig owner or the crew. It does form a basis for a record which will show the various factors which are included in the cost of the drilling operation. The drilling report includes the footage made/tour, formations penetrated and their depths, deviation of the hole, down-time for rig repair, time consumed in making trips, running straight-hole tests, circulating for samples and coring. It also includes a record of the casing run in the hole.

In addition to the company record, the crew also has a drilling report to the contractor which shows essentially the same information as the company report, except that it is more complete. Rotary speed, pump speed and pressure, amount of weight run on the bit, time of making trips, and the type of bit run in the hole, unusual conditions encountered while drilling, condition of the mud, materials used for treating mud, materials used for treating boiler-feed water, repairs made on the rig and

the replacement parts used, and the number of joints and the makeup of the drill stem in the hole. If any unusual work is performed, this also is set down.

Some companies also require a drilling-time record for certain intervals in the hole. These are desired because they give an indication of possible producing zones and offer a check on the electric log. Where mud maintenance is a problem, a special record is provided, as the complexity of the treatment prevents it from being kept on the drilling report. History of the drill-pipe and tool-joints is generally kept by the tool-pusher or in the main office.

The significance of such records is discussed. A. H. N.

406.* **Drilling Sharply Reduced under New Restrictions.** Anon. *Oil Wkly*, 9.2.42, **104** (10), 49.—On 1st February, 1942, 2659 wells were being drilled in the U.S.A., as compared with 3453 on 1st January, 1942. The fall in numbers was very marked in Texas, where the change was from 1085 to 802, and in Illinois it was from 298 to 129.

Tables give by States the total rigs in operation on 1st January and 1st February, 1942, and on 1st February, 1941, and the status of the rigs on 1st February, 1942; the total monthly completions for January and December 1941, and for January 1942, in addition to the types of completions in January 1942 and the footage drilled. G. D. H.

407.* **Gasoline-Driven Pipe Threader Skid-Mounted for Use on Barges in Marine Drilling Operations.** G. B. Nicholson. *Oil Wkly*, 23.3.42, **105** (3), 25.—One large operating company has constructed a serviceable, unitized pipe-threading machine motivated by a gasoline engine for use in remote marine areas, mounting the apparatus on skids and placing it on a small barge which is easily transported to the place where the line is to be laid, or moved to various fields in the marine-producing zone. The device offers particular advantage in erecting tank batteries and separators on piling-supported platforms over open water, where pipes of varying length are frequently used and must be threaded for making connections. The barge is mobile, and may be placed in a site where the machine is accessible to workers on the line. The complete threading machinery being unitized and skid-mounted, its movement about the deck to the most convenient place is facilitated; and when moving the barge to another location, its position on deck is also changed to occupy the least space and allow loading of additional equipment.

The threader is set on heavy skids about 8 ft. long and 4 ft. wide, made of welded I-beams. At one end of the skid is placed a stationary vice, fastened to a steel rack which is welded to the skid, its purpose being to clamp the end of the pipe while threading. Length of pipe threaded is immaterial to the performance of the machine, as two horses are provided to support pipe at a uniform and level height during threading. The horses consist of two legs constructed of 2-in. pipe welded to bases made of 14-in. joints of 2-in. pipe, with grooved saddles in which the threaded pipe rests. The legs are about 2 ft. tall, welded to the centre of the bases at a 90° angle, and brought together at the tops by means of the V-shaped saddles made of steel angles 6 in. long, to which the legs are welded. A. H. N.

408.* **Side-tracking "Sink-Holes" in Western Kansas Fields.** J. A. Kornfeld. *Petrol Eng*, February 1942, **13** (5), 27.—Three "dry-holes" in the Burnett pool of Ellis County, Kansas, were recently converted into commercial producing oil-wells by the application of side-tracking and the use of whipstocks accurately oriented towards the producing area.

Hundreds of wells have been drilled in Western Kansas in or flanking producing fields in the Arbuckle dolomite offsetting wells, and, as a result of drilling into a "sink-hole" or solution cavity, have been completed as dry holes. Dry holes have been drilled in the heart of the Burnett and Silica fields, only to be offset on all sides by later development that proved the presence of a solution cavity, covering approximately less than 10 acres. These are the reasons for side-tracking dry holes in the hope of striking near-by oil. Further applications of the oriented whipstock for side-tracking dry holes in a producing field may find wider adoption where the well does not adjoin offset leases. Fortunately, no important cavernous formations are

found in the side-tracking operations in the Burnett field. Wells structurally low in a field are sometimes drilled to lower horizons for salt-water disposal purposes, but in many cases an unsuccessful offset can be converted into a profitable producer by side-tracking. A. H. N.

409.* Record System Plays Important Rôle in Conserving Well Equipment. C. C. Pryor. *Petrol. Engr*, February 1942, **13** (5), 34.—One of the major oil companies producing more than 1400 wells along the Sabine River in Gregg County, East Texas, began a system of records for each well and lease produced by the company. The system has been in effect for the last 3½ years, and the results from its use have proved extremely gratifying to the company. As a result of the system of records set up, the lifting cost/barrel for this company is less than that of any other company in the field. Details of the system and examples of good records resulting in savings are given. A. H. N.

410.* World's First Indoor Oilfield. Anon. *Petrol. World*, February 1942, **39** (2)-27.—A short description is given of a project to form an odourless, sound-proof, fire-proof oilfield, operating completely out of sight under the roof of a modern concrete building in the city of Los Angeles. Directional drilling is envisaged. Two test-wells are planned for the first drilling programme. The general conditions having to do with this test drilling are: (*a*) test-drilling period; (*b*) emergency production period; (*c*) normal operating period.

During period (*a*) it is planned to drill two test-wells. The general conditions concerning this test drilling are: (1) The drilling location will be countersunk to a point possibly 5–10 ft. below the surface of the surrounding ground. (2) The drilling equipment and derricks will be enclosed on the sides with Transite asbestos sheets or similar material and painted or stained so as not to be unsightly in appearance. (3) Tools, pipe, and other equipment will be stored behind solid wood or similar fencing. (4) The inside of the temporary housing will be sound-proofed, if necessary, with some modest-priced material. (5) The power used will be electric. A. H. N.

411.* Less Steel—More Oil, is Problem of U.S. Drilling Contractors. Anon. *World Petrol*, March 1942, **13** (3), 62–65.—The question of maintaining drilling crews during slack periods is discussed. The problems of the U.S. drilling contractor are studied. He must drill necessary wells with less equipment than he has used before; and he must be prepared to pursue wildcatting activity in all promising areas. He must also co-operate with his fellow-contractor and the company for whom he works. To do this does not mean that he must entirely discard the competitive aspects of the business. The desire of the Petroleum Co-ordinator's office to drill 30,000 wells in 1942, and the office of the Production Management's plan to conserve steel and vital materials necessitate a new method of attack for the drilling contractor. The original O.P.C. schedule called for a full year's drilling programme in 1942, with 30% less materials. The recent 40-acre spacing rule has done much to complicate present and future drilling operations.

The total cost of drilling an oil-well is divided into three principal classifications. They are: labour, equipment, and expense. The proportions of each vary in the several districts and under changing conditions. A good average breakdown of costs shows labour to be about 33%, equipment 45%, and expense 22%. The average drilling cost in the United States is about $21,000/well. The average depth of all wells drilled in the United States annually varies from 2900 to 3100 ft. This represents an average cost of about $7·00/ft. for drilling and equipping a well for production. The cost of drilling a wildcat well is always much higher than the average for subsequent wells drilled after discovery. A. H. N.

412.* Portability as a Factor in Emergency Drilling. Anon. *World Petrol*, March 1942, **13** (3), 70.—Restrictions on normal production drilling may render certain equipment idle. This idle equipment and the fact that capacity of the steel and allied industries will be occupied on other work indicate that the normal improvement in drilling equipment will be retarded, but also emphasize the necessity for a

solution of the problem of using this equipment and trained personnel, and suggest that new techniques may be developed in order to adapt existing equipment to broader use, both in production and drilling operations.

Some assistance in this solution may come from rearrangement of the machinery to make it readily adaptable to either drilling or work-over work. The suggestion has been made that since most work-over work requires less power and auxiliary drilling equipment, the designing of skids and substructures, so that the units of equipment needed can be added or taken off as the work requirements demand, would increase the usefulness of the available equipment. Increasing the portability of the available equipment has been receiving some study, and, as a result, progress has been made in increasing the efficiency of drilling equipment, and additional progress along this line doubtless will broaden the field of application and make it possible to use equipment that would otherwise be idle because of its being at present suitable only for specialized work. Increasing the drilling range of available medium to light equipment may assist in its utilization on work for which it is now not considered suitable. Even if some sacrifice in drilling time is required in drilling at greater depths, the greater range in drilling depths may be found desirable during the shortage of equipment. A. H. N.

413.* **Drilling Economies Aid National Defence.** N. A. D'Arcy, Jr. *World Petrol*, March 1942, **13** (3), 76–79.—In light of the national emergency the development of drilling with casing in place of drill-pipe is worthy of close investigation, as it completely eliminates duplication of tubular goods in drilling. Late in 1940 a major oil company substituted 4½-in. casing for drill-pipe, and during 1941 proved to their satisfaction that it was economical to use 4½-in., 12·6-lb. casing to drill 7⅞-in. hole, 5½-in., 17-lb. casing to drill 8½-in. hole, and have conducted experiments with 7-in., 26-lb. casing when drilling 10¾-in. hole. The casing is standard Grade J, with ends upset sufficiently to provide a thickness metal under the threads equal to the normal wall thickness of the pipe. The threads are a standard cut by Pittsburgh, which is coarser than the regular pipe-thread, but a comparatively fine thread without the conventional tool-joint shoulders. Drilling with casing is a development based on the drilling costs of one major operator. The cost of the casing used runs approximately 15 c./ft. higher than standard casing, and if the normal cost of drill-pipe exceeds 15 c./ft. of hole drilled, drill-casing should be given close consideration for economy and present availability. Other economies of the system, besides the monetary ones, such as transportation, completion, and circulation, etc., are studied.

Steam and compressed-air rotary casing-tongs are described. In the same light of war-time economies, portable drilling rigs are studied. Several types are briefly described.

Bulk-cementing eliminates much of the waste prevalent when using sacked cement. Broken sacks, damaged by water and incomplete emptying, are eliminated, and even the saving in paper sacks is worthy of consideration in these trying times. Bulk-cementing is one development that won the immediate favour of the drilling crews, by elimination of man-handling cement sacks, and of petroleum engineers because of the uniformity of cement slurry produced. All major California fields are now prepared to deliver bulk cement at a saving of time and material to the operator. The new bulk-cement wagons and modern cement-pumping units are synchronized with fool-proof controls to provide a uniform cement slurry for any ratio of water to cement. It is interesting to note that the speed with which these units can deliver cement to the well is generally governed by the available water supply, not by the capacity of the unit. In the deeper and more critical wells in the San Joaquin Valley the operators are now installing special water-lines to provide sufficient volume of water to allow for the mixing and placing of 100 sacks of cement/minute with two bulk-mixing units. Cementing by this method is independent of weather conditions. A. H. N.

414. **Patents on Drilling.** J. C. Ballagh. U.S.P. 2,272,395, 10.2.42. Appl. 29.5.1939. Drill-pipe wiper made of resilient rubber composition.

J. Grant and J. J. Santiago. U.S.P. 2,272,405, 10.2.42. Appl. 20.2.39. Cutter-mounting for well-reamers and the like.

A. D. Larson. U.S.P. 2,272,529, 10.2.42. Appl. 7.3.41. Fishing-tool consisting of a barrel having at its lower end a work-receiving bore of abruptly reduced diameter, which bore is eccentric in relation to the remainder of the larger bore in the barrel.

E. Geraghty. U.S.P. 2,272,835, 10.2.42. Appl. 23.11.37. Drilling apparatus for a rotating core-drill.

A. Boynton. U.S.P. 2,273,017, 17.2.42. Appl. 30.6.39. Right and left drill-pipe connection.

J. Neufeld. U.S.P. 2,273,215, 17.2.42. Appl. 22.4.40. Well-surveying method and apparatus using radioactivity.

E. Lipson. U.S.P. 2,273,363, 17.2.42. Appl. 28.11.39. Method for electrical investigation of cased drill-holes.

D. C. Bond and C. W. Botsford. U.S.P. 2,273,925, 24.2.42. Appl. 30.11.40. Stabilized drilling mud containing starch, wheat gluten, or acid casein.

R. Fitzpatrick. U.S.P. 2,274,055, 24.2.42. Appl. 29.5.40. Cable strain clamp.

G. A. McCammon. U.S.P. 2,274,082, 24.2.42. Appl. 31.8.39. Method for construction of marine foundations for erecting a floor over a body of water for such purposes as marine drilling.

D. M. Smith and W. H. Fisher. U.S.P. 2,274,099, 24.2.42. Appl. 31.10.39. Travelling-block.

C. C. Scharpenberg. U.S.P. 2,274,168, 24.2.42. Appl. 16.7.40. Draw-works for deep-well drilling.

S. A. Scherbatskoy and J. Neufeld. U.S.P. 2,274,248, 24.2.42. Appl. 7.5.37. Well-surveying method using a heating medium and two temperature recorders placed at a horizontal and a vertical distance from the heating source.

E. J. Miller. U.S.P. 2,274,273, 24.2.42. Appl. 13.2.41. Well spider.

W. A. Loomis. U.S.P. 2,274,339, 24.2.42. Appl. 5.1.39. Means for automatic weight control in well-drilling. A. H. N.

Production.

415.* Central Separator Provides Flexible Control. N. Williams. *Oil Gas J.*, 12.2.42, **40** (40), 29.—A system of centralized separators is described and illustrated. Manifolding is such as to permit the production flow in any of three different ways or combinations. First, the production from any or all field-flow lines can be run to the testing separator. At the same time all production from any or all flow-lines can be run to either of the two regular production separators or to both the latter separators simultaneously. Also the production can be split with the flow from any combination of lines being run to one of the separators, while that of any or all the remaining lines is run to the other separator. When testing-separator is not needed for individual well-gauging, it also can be used for regular production.

All wells on the lease are completed and tested through the central individual well-testing separator. Also, all periodical testing of completed wells, including potential taking and gas–oil ratio checks, is done in the same manner. Testing procedure is described.

The entire separator and tank-battery installation is set up on a single, solid, reinforced-concrete base, which not only provides a substantial permanent foundation, but also facilitates maintenance and adds to the general orderly appearance. All valves and controls are readily accessible, permitting ease of operation. An adequate fire-wall is maintained around the site, and other necessary safety precautions are provided. A. H. N.

416.* Exhaustive Tests Performed on Oklahoma Pumping Well. Anon. *Oil Gas J.*, 12.2.42, **40** (40), 35.—This is a brief notice that strain-gauges, dynagraphs, electrical instruments, and two nine-element oscillographs were used recently in making records of over 200 operating conditions of the pumping apparatus on a 3500-ft. Oklahoma oil-well.

The tremendous mass of data compiled during the tests is now being completely analysed. Indications are that formulæ for peak pumping-rod loads, peak torques, and plunger strokes will be revised. It is hoped that proper drive, stroke, and speed for pumping wells can be selected for a particular well ahead of the time when the well must go on the pump.

Three types of drives—normal-slip induction motor, high-slip motor, and gas engine—were used on the well and were tested for performance. Effect of rotary and beam-type counterbalances was tested on the unit while using each prime mover. The unit was operated on four different strokes, from 24- to 54-in., and on a variety of speeds between 10 and 30 s.p.m. The effect of plunger size and tubing size was obtained by using two different sizes of plungers and two different strings of tubing. Shock tests on the sucker-rods were obtained by dropping the 3500-ft. rod-string several inches.

Whilst the results of the tests are not reported, it is believed that they may throw light on some unexplained phenomena, such as the breaking of a rod-string in the middle instead of at the top, where the load is supposedly the greatest. A. H. N.

417.* Operation of Electric Centrifugal Producing Pumps in Parallel. W. H. Stueve. *Oil Gas J.*, 12.2.42, **40** (40), 36.—The centrifugal pump actuated with an electric motor in the bottom of oil-wells has been adapted to producing such wells for the last 8 or 10 years, and the conventional unit consists of a 97-h.p. motor with dimentions of about 5¼ in. in diameter and 20 ft. long, direct connected through a protector about 5 ft. long to the centrifugal pump containing sufficient impellers to build up sufficient pressure to lift the fluid to the surface of the ground. The motor is usually located below the pump, and the whole unit, perhaps 49 ft. long, is suspended on the tubing, and the electric power-cable is strapped to the tubing. Variations in design of the unit sometimes locate the pump below the motor to permit the suction inlet to be set in the sump of the well-hole in cases where gas-bottom pressures are of extremely low values or entirely exhausted. Production results from the conventional bottom centrifugal pump are limited by various factors, such as the inside diameter of the casing, the depth from which the fluid is to be pumped, and of course the cost economies, keeping in mind the fixed horse-power of the motor used. In recent years motors of 135 h.p. are being used with correspondingly larger capacity pumps requiring that they be inserted in wells cased with 9-in. pipe. In wells with the fluid standing 4000–5000 ft. below the surface, the larger pumps equipped with 135-h.p. motors can produce 3000–4000 brls./day. This volume may still be too small to permit economic or paying production, but if the volume could be increased from 40% to 50%, sufficient oil could be produced together with the water to make the installation a paying proposition.

Units using two such pumps in parallel suspended one above the other, with the lower one pumping into a 1½-in. pipe by-passing the upper unit into a common 3-in. pipe, are described. The two pumps are independently connected by cable, which is strapped to the tubing supporting the pumps. The units can be used in a 9-in. casing. The entire combination of electric losses in the field electric supply lines, transformers, cable and motor, coupled with the mechanical losses in the pump and tubing friction, reveal an overall efficiency of the entire dual unit of 37% from electric metered energy at the section line to fluid delivered in the tank battery. The 150-kva. transformers, two of which are used at each well, are carrying a load of 180-kva. each, or a 20% overload, which is not excessive when consideration is given to their location in the open air. A. H. N.

418.* Cost of Producing Oil. E. Bloesch. *Oil Gas J.*, 12.2.42, **40** (40), 37.—The paper is a comment on a previous article (F. N. Bosco, *Oil Gas J.*, 15.1.1942) dealing with the same subject. It is pointed out that, in addition to costs of explorations previously mentioned, other major items may come in.

Wider spacing increases the operating costs per brl. of oil produced. To cite an extreme case: a central power on a 160-acre tract will pump with very little extra expense thirty-six wells drilled on it in a shallow field, than it would pump only four wells on this tract (40-acre spacing). However, the four wells, while probably larger per well than the thirty-six wells, would produce only a fraction of what the thirty-six would do. Where wells are operated individually, the difference in lifting cost is not quite so great, but field and office force will have to be almost the same, and again the saving in operating cost is in no proportion to the lower barrel production.

A standard 40-acre spacing may be harmful to certain fields, whilst it is ideal to others.

Again, comparing Colorado with Fort Collins–Wellington Field, which is studied in the previous paper, it is pointed out that Colorado area may be assumed to cover about 100 times the area of the one producing field. Thus expenses for geological surface work will be about 100 times the $2100 expended in the Fort Collins–Wellington Field, or about $200,000. While this amount can be substantially reduced by using reconnaissance methods, subsurface, sample, and palæogeographic studies should also be made. Assuming that geophysical work is undertaken only where surface geology has shown possibilities and where outcrops are insufficient, this may be half the area under consideration or fifty times that covered at Fort Collins.

It is emphasized that prevailing crude prices are inadequate to operate at a profit under conditions similar to those existing in North-eastern Colorado. A. H. N.

419.* Paraffin Removal by Heated Oil. T. P. Sanders. *Oil Gas J.*, 19.2.42, **40** (41), 33–34.—As compared with methods formerly used in the field, the new procedure offers the advantages of reduced treating time, more thorough cleaning, avoidance of the necessity of disturbing rods or tubing, and absence of the unsightly pile of discarded paraffin about the well-head.

Although the method depends on heated oil to dissolve the paraffin from within the tubing string, the hot fluid is not circulated: it is merely forced into the tubing to displace the cold oil, then pumped out with its load of dissolved paraffin when the well is put back on production. In order to make this operation possible it is necessary to install a simple pressure-release valve in the tubing through which the cold oil can be displaced into the annulus. This valve is placed about 1000 ft. below the interval of paraffin deposition, and hot oil is applied only to that portion of the tubing in which treatment is needed. This fact contributes greatly to the economy and time-saving features of the method. The method is described in some detail and the check-valve used on the tubing is illustrated.

Input-oil temperatures up to 450° F. with a pressure of 1000 lb. can be attained with the mobile Delta unit. With these temperatures and pressures it has been found that the unit is capable of removing paraffin from completely clogged lead-lines or from any other equipment in which deposition may occur.

If a well has been pumped too long without paraffin removal, the pump plunger may be seized by hard paraffin when a rod job is attempted for mechanical cleaning. This ordinarily necessitates stripping. However, the hot-oil unit is capable of obviating stripping even if the plunger is stuck so fast that it can be moved neither up nor down. Oil at maximum temperature pumped down the casing has been found successful in melting the paraffin to release the stuck plunger. A. H. N.

420.* Basic Principles of Closed-Type Flow-Valve Installations. J. E. Halferty. *Oil Gas J.*, 19.2.42, **40** (41), 40.—Open-type flow-valve installations are briefly reviewed. They form systems where gas-lift flow devices are run on the well-tubing, with no packer, standing valve, or other lower restriction between the casing and tubing, and no restriction between the casing and/or the tubing and the formation.

The most important considerations with which the engineer must concern himself in designing a correct flow-valve installation—after the selection of the type of valve—are: (1) the submergence of the top flow-valve below the maximum static fluid level, and (2) the maximum spacing between flow-valves. Formulæ are given to determine both the spacing and submergence.

A closed flow-valve installation differs from an open type in that the casing is packed off from the tubing above the producing formation, and further, the reverse flow

from the tubing to the formation is prevented by a standing valve. This system is particularly adaptable to wells of low productivity indices (regardless of bottom-hole pressure), and especially to wells of low bottom-hole pressure. This type of flow-valve installation is also very desirable for unloading wells equipped with intermitter depletion systems where it is essential that the applied casing pressure be kept off the producing formation.

In a closed installation, where a packer and standing valve are run and the well-fluid cannot be forced back into the formation once it has entered the tubing, the submergence of the top flow-valve below the static fluid level must take into account the ratio of annulus area to tubing area. The determination of the submergence of the top valve in a closed installation is given by the following relationship:

$$S' = \frac{C - V}{w(R + 1)}$$

where S' = submergence of the top flow-valve in a closed installation below the maximum static fluid level (in ft.); C = casing pressure (in lb./sq. in.); V = differential reopening pressure of flow-valve (in lb./sq. in.); and w = static fluid gradient (in lb./sq. in. ft.). In open-type installation the submergence $= \frac{C - V}{w}$ and the spacing of valves $= \frac{V}{w}$.

The two systems are discussed and compared. The situations where each system is preferable to the other are also discussed. The closed installation is absolutely essential where it is important to keep the applied casing pressure off the producing formation, particularly above depletion intermitter equipment where the minimum bottom-hole operating pressure is required. The closed installation has another advantage over the open-type, in that the seal furnished by the packer is much more positive than the variable fluid seal of an open installation. Also, the dry casing annulus of a closed installation protects the casing against corrosive well-fluids.

In general, the open-type installation goes in when a well is first brought in, or when it first ceases natural flow due either to a loss of dissolved gas energy or to the influx of bottom water. In wells of slow reservoir pressure decline, or wells operating under restricted flow, a long and economical intermediate flow period can be maintained with an open-type flow-valve system.

After the well passes the open-type stage—and many wells, due to their low bottom-hole pressure and low productivity index, can never be adapted to an open-type—the closed installation is the next step in gas-lift depletion. Where the addition of the bottom-hole intermitter depletion equipment is contemplated in the near future, it is usually wise to run the skeleton subpacker assembly along with the flow-valve installation. This is particularly true where the drop or removable type of intermitter valve is contemplated, since it is only necessary to drop in the intermitter valve when the well decline requires its addition to the system. A. H. N.

421.* Cost of Increased Production Measured in Terms of Steel. L. C. Converse. *Oil Gas J.*, 19.2.42, **40** (41), 46.—Using the O.P.C. estimate of 210,000 lb. of steel/well for 1942, 40-acre spacing and 200 brls./day withdrawal for 1000 days, the cost in steel is 1050 lb. for each brl./day of sustained production, or 1·05 lb./brl. of total production for 1000 days. This compares with the minimum steel requirements for the average 1940 drilling depth of 3014 ft. when 20-acre spacing and 100 brls./day withdrawal were used. As a measuring rod and for comparison the unit for new production of 1 lb. of steel/total yield or 1000 lb. of steel/brl. of daily production may be used.

Gas or air repressuring may be anything from a regular geometrical pattern with every alternate well an input well to two or three gas-input wells to the 160 acres. In any case it is presupposed that the recovery wells are already in and equipped. Although small-diameter casing has frequently been used in the past, a string of tubing cemented into the top of the sand is all that is required for gas- or air-injection wells. While the recovery/acre is much less than with water-flooding, the increase in production/lb. of steel required is definitely much less than primary production. Results of gas repressuring at Glen Pool, for instance, where new input wells were drilled, indicate a return of 1 brl. of production/0·2 lb. of S.H. steel, or one-fifth the

steel requirement for new primary production. Where old wells are converted into injection wells there may be a net gain in steel where tubing is substituted for casing in the injection wells.

Secondary-recovery production by water-flooding may be obtained all the way from 0·5 lb. of steel/brl. of crude to a net gain of 1·9 lb. of steel/brl. of gross production; examples of both of which are illustrated. It is assumed that research has proved 5000 brls./acre recoverable before any expenditure for steel is made under all conditions. The heaviest steel expenditure would be in the so-called shallow areas (500–1000 ft.), where all wells would have to be drilled.

Three-hundred-and-thirty-foot spacing 500 ft. deep or 440-ft. spacing 1000 ft. deep would each require approximately 2500 lb. of S.H. tubing and line pipe/acre or 1500 lb. of new smaller-diameter tubing and pipe as a minimum requirement for flowing condition. Under flowing conditions, only a drilling string of casing would be used, which is pulled when the tubing string is cemented in place.

Further costs in terms of steel are discussed at some length to show that in certain cases the steel being used to produce a barrel of oil may be of greater value elsewhere, at the expense of sacrificing that barrel. A. H. N.

422.* Closed Siphon System Handles Disposal Water at Tinsley. R. M. Sanford. *Oil Gas J.*, 26.2.42, **40** (42), 57.—The unit described is an entirely closed, pressure-operated system, and employs several practices previously not applicable to subsurface salt-water disposal systems. The iron content of Tinsley field brine is exceptionally high. If either the oil emulsion or the salt-water were exposed to the atmosphere, the precipitated iron oxide would clog the gathering lines and the disposal system.

Most unusual of the entire system is the disposal well. Drilled to the shallow Wilcox sands at 2880 ft., the well started flowing salt-water when tubing was run. A pressure-injection system was used to counteract the natural pressure and water-flow of disposal sand. However, since starting operation of the unit, the disposal well will, by suction, siphon water at the rate of 140 brls. hourly, or 3360 brls daily. While salt-water is being siphoned down into the well through the casing, formation water will flow out of the disposal well through the tubing. Pressure differentials in the sand section and specific-gravity differences in the salt-water are offered as explanations for this phenomenon.

The design of the system is briefly described and certain parts are illustrated. The entire plant was first designed to use a 5-in. × 10-in. pump, by means of which the water was to be forced into the injection well. When it was found that water would siphon into the well, a bypass was installed to entirely eliminate the pump. The line through the pump is still intact, however, for at some future date the siphoning action of the well may cease, and it will become necessary to resort to the pressure system of injection.

Operating through the pump, which is driven by a 500-h.p. gasoline engine, the system was first capable of disposing of 49 brls. of water/hr.; however, when the pump was by-passed, the system would siphon 96 brls./hr., or almost double the capacity. In order to increase the capacity still more, a 4-in. header with two 2-in. draw-off lines was installed on the injection well-head, and the capacity of the system was increased to 140 brls./hr. It does not yet operate at full capacity, for insufficient wells are connected to the disposal system.

The entire system has been in operation since the middle of January, and has performed so satisfactorily that several other producers in the field are preparing to install individual or jointly operated systems with neighbouring producers. A. H. N.

423.* Small-Capacity Metres Used to Gauge Well Productivity. H. F. Simons. *Oil Gas J.*, 26.2.42, **40** (42), 62.—The first method tried by engineers was to use a small portable tank and a pump driven by an internal-combustion engine. This could be hooked to the well-head, the daily production gauged, and the oil then pumped out of the gauging tank to lease storage. The pump and tank were mounted on a small trailer, which could be pulled by an ordinary passenger-car.

A new method has recently been devised which simplifies the arrangement, reduces the time spent in making the test, and gives a very satisfactory gauge on the well's

productivity. A small oil-meter is used to measure the production from the well, and the entire arrangement—meter, strainer, connections, and hand tools—is carried in a small trailer which can be pulled around the field by hand if necessary.

Gas accompanying or released from the oil being measured is often a complicating factor when metering oil, but in this case it gives no trouble, as the wells are produced under varying amounts of vacuum. The gas cannot come out of the oil, as the pressure on it is increased when it is brought to atmospheric pressure. The accuracy of the meter was checked before putting it into service by producing oil into a tank and gauging it; the meter is checked occasionally to insure against an inaccurate gauge.

The meter used is a small, positive-displacement type, crude-oil meter, which consists of two pistons travelling back and forth. The pistons are alternately filled and emptied, and are connected to a counter so that the total amount of oil moving through the meter in any length of time is recorded. It is merely a piston pump operating in reverse.

Gauging of production from a well is not complete unless some provision is made for obtaining a sample to determine the percentage of water contained in the oil. The meter also includes a small sampler, which is merely a piston with a small hole in it which moves in and out of the metering chamber. The sampler is designed to deliver 8 c.c./brl. measured by the meter. Normally the sample is caught directly under the meter, but for convenience a small copper tube is run through the floor at the front of the trailer and into a graduate cylinder held in a burette clamp attached to a short post. A. H. N.

424.* Subsurface Pressure Regulation of High-Pressure Condensate Wells. J. O. Farmer. *Oil Gas J.*, 26.2.42, **40** (42), 67. *Paper presented before American Petroleum Institute.*—Discovery of deeper reservoirs under higher pressures has resulted in the need for control equipment to preserve and protect these great sources of energy; also, means of preventing freezing or the solidification of hydrates caused by throttling or restricting production are required. The development of a successful, removable subsurface pressure regulator has enabled operators to reduce dangerously high-flowing pressures at the surface to safe working limits. By transferring the principal point of pressure reduction from the surface to warmer subsurface levels, complete elimination of the freezing conditions in flow-lines can be accomplished. Development and operation of a subsurface regulator are described, and charts and tables for use in determining proper depths for pressure reductions to prevent freezing are shown. Other beneficial results, heretofore considered subordinate, such as the reduction and stabilization of gas–liquid ratios in condensate-producing wells and the retardation of water encroachment, have been observed. The possibility of establishing conditions in the tubing string favourable to the precipitation of condensate through the use of subsurface regulators is suggested. Further technical research relating to the use of subsurface regulators for controlling temperatures and pressures in the flow-string to obtain conditions most conducive to the precipitation and an increased recovery of condensate is desired.

The degree to which the regulator valve opens depends on the size of the surface choke used; the larger the choke, the greater the reduction in the downstream pressure; hence, the differential pressure across the regulator will be increased and the regulator valve will be opened wider. Conversely, selection of a smaller choke at the surface will cause the regulator valve to move to a position of less opening and restrict the flow. The operation of the regulator is therefore entirely automatic, and variable rates of flow at substantially constant delivery pressures can be maintained by merely adjusting the surface choke. The daily delivery can be varied through a range of from zero to 9,000,000 cu. ft.; the maximum rate, however, is dependent on the ability of the well to produce at the reduced flowing pressure.

To eliminate the terrific abuse caused by the abrasive action of flow under differential pressures exceeding 1500 lb./sq. in., it is the general practice to limit the pressure reduction across a single regulator to a maximum of 1500 lb./sq. in., and to use two or more regulators in series where greater pressure reduction is required. In multiple installations the regulators are spaced at intervals of 500–1000 ft., and are so adjusted that the total pressure drop is divided among them to give optimum service. A. H. N.

425.* Central Electrical Generating Plant Designed for 160 Wells. H. E. David. *Oil Gas J.*, 26.2.42, **40** (42), 74.—The plant is at present used for pumping eighty-four wells, and is designed for the ultimate operation of 160 wells. Each well is producing an average of 50 brls. daily. The Griffin field, in which the plant is operating, is described. The loads on the individual wells vary from 3 to 10 h.p., depending largely on the formation from which the well is producing. Most of the wells are pumped 24 hrs./day, a very few being pumped on a part-time basis. Each well in the Continental system is equipped with an individually geared pumping unit driven by an electric motor. On the majority of the wells these motors are 440 v., 3-phase, 10–12-h.p., 60-cycle, 1200-r.p.m., induction-type, capable of running continuously with not more than 40° temperature rise. The electrical system is described in some detail.

From the past history of Griffin and other Illinois and Indiana fields, the period of peak oil production is quickly reached, holds steady for a period, and then gradually declines. With the present installation 160 wells can be handled at their present rate of production. As the volume of fluid to be handled falls, more leases and wells may be added, or the size of the plant may be reduced by removing one of the units to a new location where it can be utilized. A. H. N.

426.* Strategic Location of Wells in Flank Sands on Piercement-Type Salt Domes. Anon. *Oil Wkly*, 9.2.42, **104** (10), 17–20.—The 40-acre spacing provision is particularly disturbing to operators of the Texas–Louisiana Gulf Coast, where geological conditions themselves prevent rigid well-spacing regulations if maximum efficiency and conservation are to be obtained. In view of the fact that piercement-type salt domes of this area yield crude oils that are particularly needed in prosecution of the war, being desirable for making aviation gasoline, bunker oil, and diesel oil, it is imperative that the matter be given prompt attention by those administering the spacing provisions.

The successful and efficient development of these domes, with their multiple, tilted, and faulted oil-sands, requires exceptional care in the selection of drilling sites, a fact heretofore developed after long experience and fully recognized by State conservation authorities.

After describing the conditions in these fields, the following conclusions are recorded: The flank sands are separated by radial faults into segments which require one and often several wells/segment to withdraw the oil.

A spacing programme to fit the size and shape of the individual segment and the position of the oil-sands is required. A set pattern for location of wells will not apply, and would result in a large percentage of dry holes, with consequent loss of essential materials.

Governmental authorities should afford such exceptions to general regulations that salt domes may be developed with spacing and location of wells that will provide maximum efficiency. A. H. N.

427.* Decreased Costs and Improved Well Performance Gained Through Pumping Equipment Modernization. G. M. Wilson. *Oil Wkly*, 9.2.42, **104** (10), 24.—Probably the most familiar of all pumping equipment, and the type that is probably most sorely in need of repair or replacement, is the old standard-end pumping unit, with its single-cylinder engine, long belt, and band-wheel.

The replacement of this type of plant by slower speed and more efficient types is discussed. One company owning a large number of wells equipped with this older equipment has in the last two years reconditioned some sixty-two wells by partly re-equipping them in the manner generally outlined above. Substantially better performance and lower maintenance costs have been realized in those wells since the programme was started.

The reconditioning work, directed primarily towards the elimination of the large single-cylinder engines to make possible the addition of certain new equipment designed to adapt the well to slow-speed pumping, was begun on each well only after an exhaustive survey was made of the production rate, water cut, normal operating fluid-level, plunger loads, and general condition of the band-wheel, pitman, walking beam, and derrick.

Average gross production rates of wells that were reconditioned vary from 25 to 100 brls./day, with water cuts in some wells running as high as 75–90%. Wells were

pumped from depths varying from 2300 to 6800 ft. Pumping with the old equipment made it difficult, and usually impossible, to slow the engine down to a speed where the pump would handle the fluid only as fast as it came into the hole. If a well pumped faster than this optimum rate, the plunger pounded fluid, tending to increase formation of B.S., causing rough action of the pumping strokes, and in general bringing about early trouble in the form of worn pumps, broken rods, and overhauling of surface equipment. Details are given of one well in particular.

On certain wells, other than those which were equipped with small electric motors, it was sometimes found to be more economical to install multi-cylinder gas engines in connection with a countershafting arrangement. This condition was found to be particularly true in wells which required power ranging from 10 to 20 h.p. and higher.

In such instances the belt and band-wheel were retained, and used in connection with a countershaft that was usually made up out of the former gas engine, or the crank and base of an old steam engine. In case of a certain set of conditions which required a particularly heavy shaft, a specially designed countershaft was used. A V-belt drive connected the engine to one side of the countershaft, with the flat belt taking off a pulley on the other side.

Salvage is discussed.

A. H. N.

428°. Reduction of Hole Size in Drilling as Affecting Costs, Completion, and Production Practice. Part II. I. W. Alcorn and J. U. Teague. *Oil Wkly*, 9.2.42, **104** (10), 32. *Paper Presented before American Petroleum Institute.*—After a detailed study of the problems involved in the production from small-size wells the following conclusions are recorded: (1) Small-diameter wells are substantially lower in cost than large-diameter wells, in every field on which information was submitted. (2) A small-diameter well is considered to be one completed with 5½-in. O.D. casing. This is regarded as the minimum practical size for well completion by the majority of those submitting data. However, wells are being completed with smaller sizes as an experiment. (3) There was no difference in potentials between small- and large-diameter wells when taken on chokes ¼-in. in diameter or smaller. (4) Small-diameter wells can be completed by all common completion methods as easily as large-diameter wells. (5) All types of artificial-lift equipment can be used satisfactorily in small-diameter wells. If large volumes of fluid are to be produced, especially with rod-pumps, the small-diameter wells may impose some restriction. (6) Small-diameter wells can be repaired as easily and cheaply as large-diameter wells, except when it is desired to deepen or side-track wells. For these two exceptions the small-diameter well is not satisfactory. (7) In view of the current low rates of production, the long-expected flowing life of most fields, and the attractive savings realized, the trend towards drilling and completing small-diameter wells will probably continue. (8) It should be pointed out that the scope of the paper has been limited to the presentation of the actual experience of the industry to date in drilling and completing small-diameter wells as it affects costs and operation. No attempt has been made to determine or discuss the effect the small-size hole through the producing horizon has on the productive capacity of the well, or the effect it may have on ultimate recovery. A. H. N.

429. Efficient and Flexible Gathering System. G. M. Wilson. *Oil Wkly*, 23.2.42, **104** (12), 23.—Outstanding among the points of interest in the lease-gathering system are: (1) Three stages of separation before the oil reaches the large lease-tanks. Individual well-gauging is accomplished in weigh-meters in the second stage of separation, making unnecessary the use of small lease gauge-tanks. (2) Complete stabilization of the oil in the tanks, which results in the elimination of gas wastage, and a marked absence of turbulence of the fluid in the tanks. (3) Efficient use of two small and one large compressors to boost the gas taken off at the second and third stages of separation, up to the pressure of the initial or high-pressure stage, thus making for simplified disposal into the field gathering-line of the utility company. (4) A number of smaller but very interesting operating ideas that contribute greatly to the ease and efficiency of operation of the wells and the gathering system. The development of the lease is detailed. Each of the four items is also discussed in more detail.

To aid in the efficiency of operations a unitized header for each well is used. The flow-header consists of an 11-ft. length of 9-in. heavy casing, welded closed at each

end to withstand the maximum anticipated flow-pressure. Flow-lines from both sides of the Christmas tree are hooked up to the back side of this chamber, and the lead-line going up to the trap-setting takes off from either end. Two steel legs welded to the bottom of the header are cut out of short section of I-beam material, and provide a sturdy base to minimize vibrations.

Mounted on steel supports welded to, and extending upward approximately 1 ft. above the top of the flow-header, is another smaller and somewhat shorter chamber. This chamber, made of 6⅝-in. casing, is 5 ft. long, and is divided into four equal compartments, which were made by welding steel plates between cut-out sections of the pipe. Each section is a separate receiving chamber for pressure taken off from (1) tubing or flow-string, indicating oil or gas pressure in the lead-line on the down-stream side of the flow-bean; (2) between the water and surface strings of casing, which, although under all normal conditions they should be zero, must nevertheless be constantly checked; (3) the inner casing string; and (4) tubing head, recording the tubing pressure (flowing or static) on the upstream side of the flow-bean.

Pressure enters the compartments through a ¼-in. collar welded into the back side of each chamber. Half-inch collars, nipples, and tees on the top provide an outlet for pressure gauges, as well as for a recording meter. The latter is mounted at eye-level height on an upright piece of 2-in. pipe screwed into a fitting that is welded to the front of the flow-header chamber. A ¼-in. outlet and bar-stock valve below each compartment allows fluid to be drained out into a common waste-gathering ¼-in. line, which then extends on over to a hole cut into the wooden cellar-floor. The entire header assembly can be dismantled in comparatively large units when wells are to be worked on.

Other equipments are similarly described. A. H. N.

430.* Unsteady Flow of Vaporizing Hydrocarbons through Unconsolidated Sand. T. Y. Ju and R. L. Huntington. *Oil Wkly*, 23.2.42, **104** (12), 32.—The paper is a report on a research project carried out to investigate the behaviour of reservoirs producing hydrocarbon vapours which are in contact with their own liquids. An artificial reservoir, composed of 93½ ft. of a 2-in. A.P.I. pipe, mounted vertically and packed with unconsolidated Wilcox sand, was used to investigate the production characteristics of butane and propane reservoirs. The curve for production rate decline of a reservoir of this type was found to be similar to that for the usual gas reservoir. The cumulative production is related to the cumulative time by an exponential function relation. The production-rate equation developed for ordinary gas reservoirs was modified, and the modified form was found to be applicable. For butane and propane reservoirs it is quite possible, therefore, from the known production data, to estimate the future cumulative production and future production rates by means of these empirical relationships.

In this, the first part of the paper, a description of the apparatus, its mode of filling and use, and of the procedure adopted is given, together with tables showing the results of five runs. The results are to be discussed further in two succeeding parts.
A. H. N.

431. Value of Planned and Controlled Operations Demonstrated by Successful Shallow Water-Flood. G. M. Wilson. *Oil Wkly*, 23.3.42, **105** (3), 17–22.—The feasibility of successfully water-flooding many shallow, semi-depleted oilfields in certain areas of West Central Texas has definitely been proved in at least one project started in the early part of 1941. A group of fourteen wells, producing from a sand at 350 ft., the total lease production of which had slumped to only 4 brls./day, and to which were later added fourteen more wells (twelve of which are re-drilled, formerly abandoned wells), on adjoining leases, have responded to water-flooding to the extent that the twenty-eight oil-wells are now producing a total of 4000 brls./month, with the rate still on the increase, after only eleven months of active flooding operations. The field is described.

Several conditions, operating as well as economic, in this field, appear to lend themselves ideally to secondary recovery by water-flooding methods.

First is the shallow depth of the oil-sand, being only 350 ft., and which has no water-sand overlying it, making it unnecessary to case the injection wells or any oil-wells that may be drilled on the property in the future.

Second are the uniformity and extremely high permeability of the oil-sand. Permeability ranges from 350–500 millidarcies. This compares with 75 for the Bartlesville sand of Oklahoma and Kansas, and from 6 to 20 for the sands of the Bradford, Pennsylvania, region. Sand porosity averages 25%. So far as is known, this sand is the highest average permeability of any so far attempted for water-flooding.

Still another factor favourable to water-flooding is the close proximity of an ample supply of fresh water, the source being a lake several miles north of the field.

The drilling of injection wells by inexpensive methods, storage tanks, pumps, and other items of the system are discussed. A constant pressure of 320 lb. is being maintained at the pumping plant. Plant injection pressure has been gradually increased from approximately 250 lb. at the beginning of the flood up to the present value. Pressure is held constant by means of a back-pressure valve tied in to the discharge line near the base of the pump. Excess water is by-passed back into the suction line of the pump. The water system, the tests undertaken, and their interpretation are described.

Several noteworthy conclusions are reached, particularly the fact that small projects, covering only a portion of a field if necessary, can be successfully flooded.

A. H. N.

432*. Wild Gas-Well is Controlled. Anon. *Oil Wkly*, 23.3.42, **105** (3), 23–24.—A photographically illustrated description is given of a method used to control a gas-well which blew wild an estimated 20–50 million cu. ft. of gas. The method consisted of lowering a control gate-valve and setting it into the well-head. A. H. N.

433.* Determining Fatigue in Sucker Rods. W. A. Sawdon. *Petrol. Engr*, February 1942, **13** (5), 23–26.—The testing service described in this paper utilizes a magnetic method of measuring the fatigue in steel, and is based on the fact that no two pieces of steel can have the same hysteresis curve unless they are identical in chemical composition, heat treatment, and physical characteristics. The rod to be tested is inserted in a coil that is excited with alternating current. The flux induced bears a direct relationship to the physical characteristics of the steel, and if a second coil is brought into inductive relationship to the rod, the voltage induced in it will also bear a direct relationship to the physical characteristics. As the physical characteristics of the steel change, small changes occur in the induced voltage, and these changes can be correlated to the physical characteristics. By properly arranging the circuits and exciting the material, the development of fatigue is established by measuring the phase angle that occurs in the induced voltage.

Two recordings are made on a chart, and these show the characteristics of the steel in the sucker rods. One recording is the phase angle that identifies the fatigue, and the other is the magnitude of the change. The charts obtained are illustrated, and the method of use is described fully, together with certain typical sets of results of such tests.

It appears from the results obtained to date that replacement of rods by fatigue-test data has been effective and economical. In many cases more new rods have been bought at one time, but by the replacement of rods definitely shown to be fatigued many subsequent pulling jobs have been eliminated. The broken rods have to be replaced in any case, so by doing the job at one time a number of shut-downs and the expense of pulling and frequently fishing for rods have been avoided. In testing a pile of salvaged rods there will also be more rods junked, but as such rods would only cause trouble if run into a well, their retirement is economical. Moreover, by classification of the rods they can be put into a service within their limitations, and rods well able to handle light duty will not be over-stressed and begin to give trouble.

Considerable study has been given by one of the major companies on when it is profitable to test a string of rods in a well. Exclusive of the value of deferred production, it was concluded that it pays to test the string when the frequency of rod failures exceeds a rate of one break in 60 days.

Another company has found that in the average well the number of rods to be replaced appears to have a direct relationship to the frequency of breaks. The ratio is approximately 1·25 times the average number of breaks a year, which, for a well having one break in 60 days, would be seven or eight rods. In a well with fifty breaks

a year, the number of rods to be replaced would be sixty-two, which would still be only 30% of a 6000-ft. string.

It must be remembered that little corrosion is encountered in most California fields when compared with many other oil-producing areas. Fatigue induced by corrosion is therefore not so prevalent; but even small corrosion pits are a definite source of fatigue. A. H. N.

434.* Wells in Big Lake Field Now Pumped by Power from New Generating Plant. F. H. Love. *Petrol. Engr*, February 1942, **13** (5), 53.—The plant described has an output of 2000 kw./24-hr. day. This output is distributed to the several consuming outlets by three feeder circuits. One circuit feeds a bank of four 1000-kva. transformers, of which one is a standby that steps-up the voltage from 2300 to the 13,800 volts required for field operations. A second circuit feeds three 2400-kva. transformers that reduce the voltage to 110–220. This power is used by the company camp and the town of Texon. A third circuit, for operation of the generating plant's auxiliary equipment, feeds three 50-kva. transformers.

In the field, power generated by the plant is pumping 145 wells that produce from depths of 2900–3100 ft., and four that produce from a 2400-ft. zone. Sectionalized pole-top disconnecting switches have been installed, one at the plant and several throughout the field, so that, should the load become inadequate at any time, a part of the field can be removed from service.

On the individual wells a special thermal overloading relay allows for a long starting period. After the well is pumping, the thermal overload relay is set for a lower rating, equivalent to the pumping load of the well. Should an overload occur due to rod break or some other cause, the overload relay will trip and clear the well from the line.

The motors used in the field are double-rated, variable-speed, slip-ring units. To pump the wells, motors of 15 h.p. at 575 r.p.m. are used, and for well-servicing they are 35 h.p. at 1160 r.p.m.

The plant equipment and other details are described and illustrated. A. H. N.

435.* Flexibility and Efficiency of Two-Zone Completions Proved in Condensate Field. W. R. Brown. *Petrol. Engr*, February 1942, **13** (5), 66.—In the conventional double or two-zone completed well the casing is perforated opposite the upper formation and again opposite the lower formation with a production packer separating the two formations, in order that one may produce through the casing annulus and the other through the tubing. In distillate wells, even in this high-pressure district, the gas flowing from the formation forms a liquid due to retrograde condensation, and loads up the casing annulus, finally shutting off the flow of gas, because the velocity of the gas-stream is not sufficient in the large area of the annulus to keep the liquid in the gaseous phase.

A special valve was designed to remove the load of condensate from the casing annulus. The valve, exclusive of the 1¼-in tubing, is made up in the 4-in. tubing string used in wells in the field, and is placed between the upper producing formation and the packer separating the zone producing through the tubing from the zone producing through the casing. It is designed with passages through the valve-joint around the valve mechanism to permit flow from the lower formation at all times through the annulus between the 4-in. and 1¼-in. tubing. After the tubing string is set in place on the bottom of the hole and the packer set, the 1¼-in. tubing is run with a guide to, and made-up in, the Lewis valve. As the surface end of the 1¼-in. tubing is made-up with a hollow piston-rod, it is necessary to allow for stretch and temperature expansion before the tubing is cut and the connection made. The operation of the valve is simple.

Distillate in the Stratton field, because of the temperatures and pressures, exists in the formation only in the vapour phase. A decrease in bottom-hole pressure would therefore present occasion for retrograde condensation within the sand, resulting in a large part of the distillate wetting the sand and becoming unrecoverable. Operators are thus required to maintain a close check on pressures of the well and individual sands to prevent the occurrence of condensation below a predetermined pressure. When this point is reached production from the sand is discontinued, and in case both sands are regarded as depleted at the same time, the well is then converted into a

double injection or input well. Distillate remaining in the sand in gaseous phase may be recovered from some other well completed in the same sand, as dry gas being injected into the sand apparently moves in a wave front away from the well-bore with a little mixing or diffusion with the rich or distillate-bearing gas. Other producers in the same sand some distance from the input well will eventually become dry-gas producers, and may then be converted into input wells, but the condensate will have been recovered by that time. A. H. N.

426.* Petroleum Engineering. Part 2. L. C. Uren. *Petrol. Engr*, February 1942, **13** (5), 82.—Professor Uren concludes his paper on educating a petroleum engineer by giving a full description of the courses considered as minimum requirements in colleges. A. H. N.

427.* Depleted Sands Serve as Safe, Economical Oil Storage. F. R. Cozzens. *Petrol. Engr.*, February 1942, **13** (5), 162.—Natural gas has been returned to depleted sands in fields near Pittsburgh, Pennsylvania, and Louisville, Kentucky, and later successfully recovered. In various stripper-oil districts, especially in South-eastern Ohio, it has long been a practice to introduce into depleted wells fresh crude oil in quantities ranging from 50 to 1000 brls., for the purpose of cutting paraffin and sludge. In many such wells the oil was forced into the sand by air-pressure, and left dormant for a period of 90 days and longer. When these wells were reopened and pumped vigorously, the measured quantity of injected oil was taken out, plus a higher than normal drainage from the oil-sand. The increase in normal drainage was undoubtedly due to the solvent effect of the injected oil on any deposit of paraffin and sludge on the face of the sand. Calculations were based on previous sand-core tests, showing an average oil content of 200 brls./acre-foot of sand. Previous pumping records in these fields showed an oil recovery of 180 brls./acre-foot, so it could be estimated fairly accurately that the injected oil was entirely recovered. As such tests have been scattered over wide areas, and made in sands of various textures, there is ample reason to believe that larger quantities of oil can be injected and recovered at will by modern recovery methods. Certain sands cannot be used for storage, as oil thus pumped into them is irrecoverable.

For his experiments, the operator chooses a district of settled production, and a sand virtually depleted of oil (containing less than 200 brls./acre-foot). By coring, or from records of previous drilling, he charts three to ten wells in a restricted area (5000 ft. or less), where the producing sand is fairly uniform in thickness, colour, and porosity. Pumpers are then given instructions to compute carefully the output of production from each well, and to observe whether they build-up uniform "heads" of oil between pumpings, also whether wells nearest the edges of the sand-body respond with a gradual increase of production when other wells near the centre of the reservoir sands are left dormant. After such observations have been made over a period of weeks, or even months, the operator has gained fairly accurate knowledge as to his project's possibilities in safely retaining oil. If air or gas pressure is or can be used, he can inject small quantities of oil and compute the effort and expense necessary to recover it. These and numerous experiments and calculations can be made on a sand by the operator and his crew without excessive cost. A. H. N.

428.* Field Application of Core Analysis and Depth-pressure Methods to the Determination of Mean Effective Sand Permeability. N. van Wingen. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1464, 1–5.—The permeability profile of a producing horizon can be integrated graphically to give an average permeability for the horizon. The dry pore permeability of each sample can be corrected to give a true measure of the ability of the horizon to transmit oil, provided that the percentage of connate water is known.

Effective sand permeabilities can also be estimated from analytical studies of field-pressure measurements. In one method the time rate of pressure build-up after a well is shut in from steady state flow is required, and in the other the direct measurement of a steady state rate of flow and the corresponding equilibrium pressure is employed.

The methods outlined are applied to two wells, and the results obtained from core-analysis data, from the rate of pressure build-up, and from the productivity index are

compared. Results obtained by the last two methods are similar, and considerably lower than those obtained by the first method. G. D. H.

439.* Oil-Well Spacing, War, and Geology. Anon. *Petrol. World*, February 1942, **39** (2), 24.—The main thesis of this paper is that a standard oil-well spacing programme for all areas might be as injurious to certain areas as it is beneficial to others. The oil-fields of California are studied in particular detail. Certain misconceptions are discussed. For instance, the much-criticized Long Beach field is actually wider spaced/acre foot of oil-sand than some of the model development examples of the east. The principal area of some 1300 acres with some 1400 wells has well in excess of 1000 ft. of oil-sand. This results in roughly one well/1000 acre ft. of sand. It is therefore comparable to developments elsewhere with 10-acre spacing and 100 ft. of sand, or 100-acre spacing with 10 ft. of sand. Recovery has been about half a million brls./acre.

Furthermore, neither the economic import nor the sociological and military aspects can be ignored. The great per-acre yield caused lease values to reach, and sometimes exceed, $5000/acre. A 40-acre spacing regulation in 1923 would have had the practical and anti-social effect of handing over this reserve of well over half a billion barrels of oil to a handful of operators, because only those few could have been able to acquire 40 acres at $5000/acre and then drill a well.

Such a ruling would have required at least $250,000/drill site for participation in the Long Beach oil reserve, and would thus have removed from many citizens their right to engage in the oil business. However, under "close" spacing a number of independent operators got their start in the oil business. And a number of those companies, because of healthy subsequent growth elsewhere, developed from that start to a position to-day of being capable each of supplying the entire west coast military needs for petroleum.

Thus, it is emphasized that California should find its own well-spacing programme, regardless of what is found to be of optimum value elsewhere. A. H. N.

440.* Economics of the Modern Pumping Unit. J. R. Thomas. *Petrol. World*, February 1942, **39** (2), 29.—The paper discusses the economics of the modern pumping unit in comparison with the older system, with special reference to maintenance and cost of operation.

The advantages of modern units over the old standard and with single-cylinder engine are listed as: (1) Smoother motion, thus less wear and tear on subsurface and surface equipment. (2) Lower fuel and lubrication costs. (3) Lower maintenance in: (*a*) prime mover; (*b*) gear-box as against reverse clutch. (Reverse clutch should be stressed, as it is probably the most expensive single piece of equipment to maintain in the standard end.) (4) Reduction in belt trouble. (5) Reduction of labour in starting engines. (6) Less down-time as a result of above reductions. (7) Larger realizable salvage. Each of these items is discussed after a brief discussion of the economics of a change-over. Other advantages of the newer-type equipment are mentioned, but are not considered in detail. In the floor unit especially the haphazard lubrication of bearings on the saddle, pitman, and crankshaft is eliminated. It is impossible to keep the areas around the sampson post and crank clean with this type of lubrication, where the pumper throws the oil at a bearing and hopes that some of it gets in the right place. This practice creates a definite fire hazard and does not improve the operator's safety rating. A good deal of oil is wasted. Another factor worth mentioning is that one pumper can properly tend twice as many wells equipped with modern units, due to the less frequent need for lubrication, adjustment of lubricators, etc.

Typical savings are cited. A. H. N.

441.* Band-Wheel Drives Pay Out Quickly. G. E. Henderson. *Petrol. World*, February 1942, **39** (2), 31. *Paper Presented before American Petroleum Institute.*—The discussion is confined to band-wheel drives, wherein existing standard ends, less the power equipment and long belts, are usually utilized. The name "band-wheel drive" as used here is really a misnomer, as all wells equipped with band-wheels for pumping are band-wheel drives. However, during the last ten years, through general usage, the term "band-wheel drive" has been supplied to units that use small motor with necessary reduction to use the band-wheel shaft to pump wells at slow speeds.

Actual cases are cited and analysed in detail to illustrate the savings, among other advantages, of the system. Both the economical and engineering aspects are studied.

When band-wheel drives are properly installed and engineered, the life of the equipment has already been shown to be in excess of 10 years, as maintenance on equipment as old as this is still negligible. This is particularly interesting as applied to the life of chain. There are many records in the San Joaquin Valley of unprotected chains having run for 10 years without replacement.

A decision as to whether or not the existing equipment should be replaced on a producing well is purely a matter of economics. This depends on the volume of production, condition of rig, and lifting costs. The band-wheel drives are not a cure-all for all producing wells. However, there are still a large number of wells in California where the instalment of special equipment such as the band-wheel drive would pay for itself in 6–19 months.

The application of the band-wheel drive fits into national defence, inasmuch as it utilizes the maximum amount of the existing equipment, and thus conserves material for war-time uses. A. H. N.

42.* War-time Problems of the Petroleum Producing Industry. L. C. Uren. *World Petrol.*, March 1942, **13** (3), 48–53).—American authorities have formulated objectives for the petroleum producing industry: "(1) Produce at least 1,500,000,000 brls. of crude petroleum if that quantity can be supplied without impairing the ability to sustain the necessary production during the emergency. (2) Drill a sufficient number of wells, efficiently spaced, to furnish that amount of oil next year and to prove up sufficient reserves to furnish at least that amount during the following year. (3) Operate all wells so as to conserve reservoir pressure to the end that the greatest practicable ultimate recovery will be attained at the lowest possible cost, with minimum expenditures required to provide artificial energy to effect production. (4) Conduct an exploration campaign that will result in the discovery of new supplies adequate to maintain a comfortable ratio between reserves and current annual consumption. (5) Maintain surface stocks of crude oil at adequate levels with respect to refinery requirements for the various grades and qualities of products, as well as stocks of the products sufficient to protect against any unusual demand that may arise."

The realization of these objectives forms the substance of the paper. It is noted that it is fallacious to assume that the U.S. oil industry can produce what will be required by merely opening flow-valves, as each reservoir has an optimum rate of flow. The daily rate of production that could be had from present-known fields of the United States without exceeding the economic optimum rate of production has not been determined. Some authorities believe that it does nor greatly exceed the present daily production rate. The writer has lately sought opinions on this matter from men in the industry qualified to express such an opinion, and the resulting estimates have in most instances been between 4,000,000 and 5,000,000 brls./day. The current rate of production (January 1942) is about 4,100,000 brls./day. Col. E. O. Thompson has stated that in his opinion fields now producing in the United States cannot support a production of 5,000,000 brls./day over a long period of time without loss in ultimate recovery. In other words, it would appear to be the considered opinion of competent authorities that production much in excess of the present daily rate cannot be maintained economically from present reserves, and any additional supplies that may be needed should be provided by discoveries of new reserves. Apparently substantial increases in production are possible only in Texas and California, and even in these States only moderate increases are possible if the increased rates are based on consideration of conservation and maximum ultimate recovery of petroleum resources.

Increased production implies intense exploration and drilling programmes. Estimates by competent authorities indicate that at least 30,000 new wells should be drilled in the United States during 1942. Probably more than this will be needed if we are to maintain reserves and provide sufficient flush production to meet prospective crude demand. The average well drilled in the United States during recent years has been about 3000 ft. deep. Assuming that this average depth may conservatively be applied, it would appear that the total footage drilled during 1942 should be at least 90,000,000 ft. The average cost/ft. of drilling has not been determined recently, but possible averages are about $7 or $8, including casing and fixed charges. The total expendi-

ture of the industry for new drilling may therefore aggregate nearly $750,000,000 for the year 1942.

The long paper discusses further the problem of spacing, rehabilitation of idle stripper-wells, power requirements, and the need of maintaining a large number of skilled man-power. A. H. N.

443.* Transferring Well Allowables to Conserve Steel. H. M. Staggs. *World Petrol.*, March 1942, **13** (3), 71.—The effects of the present hostilities on production of oil are briefly discussed. Conservation of oil production may be defined as the production of the greatest possible amount of oil with the smallest possible amount of energy. This is of the greatest importance for several reasons, chief of which are ultimate oil recoveries and more oil produced by natural flow. The most satisfactory means of accomplishing such conservation would be by Unit Operation, where the entire pool is operated under one management. This would make possible long-range planning for the best interests of all concerned. Some progress has been made along these lines in recent years. However, complete Unit Operation is not fully accomplished except in a few instances; therefore, more progress is much to be desired. In the absence of Unit Operation, some accomplishments that would aid in conservation would be to create units within a field for operating purposes whereby the allowable of such units could be produced by any well or combination of wells in the unit to conserve reservoir energy. Thus gas energy could be conserved by producing lowest gas-oil ratio well or wells in each unit. The transfer of allowables from high-volume water producers to other wells on a lease, as is suggested in some fields, will assist in the conservation of both reservoir energy and artificial-lift equipment. Where wells are closely spaced, some system of allowable transfer to offset wells on the same lease would free large quantities of artificial-lift equipment for use elsewhere. Where possible, wells should be reworked and natural flow re-established in preference to the installation of artificial-lift equipment. A. H. N.

444.* Sustaining Productive Capacity during the War. J. H. Abernathy. *World Petrol.*, March 1942, **13** (3), 72–75).—Means available for increasing productivity of producing wells falls into two classes: (1) Producing from a new pay-zone. (2) Increasing production from the present pay. Within these broad classes, however, divisions are numerous. In the first class, the well may be drilled down to tap known or suspected deeper horizons, or, conversely, the well-casing may be opened opposite zones which were penetrated in the original drilling. Methods for two-zone production which have been recently developed will, no doubt, find an increasing use. In drilling deeper, some of the problems encountered are: protection of the zone from which production had previously been taken, in order to avoid contamination and other damage to the formation; proper casing, cementing, and mudding practices to minimize use of materials and to avoid damage to equipment already in the well; and working out fishing jobs and completion and production problems occasioned by the small holes that must necessarily be cut in most deepening work.

The second class of increasing production is briefly sketched, as it can represent an almost unlimited number of alternatives. Water encroachment may be retarded, gas repressuring employed, etc. Yet another group of wells exists in which decreasing production is largely the result of mechanical failures. The screen may be corroded or plugged with sand, shale, or gypsum. The screen may have collapsed by moving sand or cut out by erosion resulting in a sanded-up condition. In areas where corrosive water or electrolytic conditions are encountered, holes or breaks may occur in the well-casing itself. Similar difficulties may appear owing to casing wear if the well is baled or swabbed for extended periods of time, especially if the hole is crooked. Some of these mechanical difficulties are almost indistinguishable at the surface from other types of well troubles, and great care must be exercised in determining the repair procedure, otherwise irreparable damage may be done to the well. A. H. N.

445. Patents on Production. J. E. Frances. U.S.P. 2,272,194, 10.2.42. Appl. 23.9.39. Pipe-joint.

C. M. Williams. U.S.P. 2,272,388, 10.2.42. Appl. 25.1.40. Controlled pumping choke for oil-wells.

D. D. Perry. U.S.P. 2,272,579, 10.2.42. Appl. 3.10.40. Well-pumping mechanism for driving the walking beam.

H. T. Kennedy. U.S.P. 2,272,672, 10.2.42. Appl. 23.3.36. Water-flooding of oilfields and using a reagent to produce plugging in the formation.

H. T. Kennedy. U.S.P. 2,272,673, 10.2.42. Appl. 24.3.36. Gas repressuring of oilfields and using a plugging reagent in the formation.

K. F. Budd. U.S.P. 2,272,963, 10.2.42. Appl. 19.10.39. Swab comprising a mandrel and complementary swab sections.

M. De Groote and B. Keiser. U.S.P. 2,273,181, 17.2.42. Appl. 7.7.41. Process for breaking petroleum emulsions by means of a chemical.

R. C. Farley and J. W. Gillespie. U.S.P. 2,273,349, 17.2.42. Appl. 18.8.38. Pumping apparatus which can be lowered into a well and removed therefrom on a flexible line.

F. E. Wellman. U.S.P. 2,273,915, 24.2.42. Appl. 18.3.38. Process of desalting petroleum crude by means of contacting with water and settling.

B. D. Hays. U.S.P. 2,274,062, 24.2.42. Appl. 23.8.38. Differential pressure unit for flowing-wells having a casing.

R. P. Miller. U.S.P. 2,274,084, 24.2.42. Appl. 13.5.40. Valve for pumps of the automatic fluid-pressure type.

D. Ragland and J. U. Teague. U.S.P. 2,274,093, 24.2.42. Appl. 19.10.38. Apparatus for completing submarine wells.

C. H. Sweet. U.S.P. 2,274,107, 24.2.42. Appl. 10.2.40. Paraffin cutter for use in the oil-production tube of a flowing well.

C. Irons and S. M. Stoesser. U.S.P. 2,274,297, 24.2.42. Appl. 16.12.38. Method of treating earth and rock formations by means of a solidifying resin-forming liquid.

O. Hammer. U.S.P. 2,274,407, 24.2.42. Appl. 9.8.39. Means for producing from spaced oil-sands one of which requires pumping.

J. H. Howard and J. H. McEvoy. U.S.P. 2,274,477, 24.2.42. Appl. 24.8.39. Tubing hanger for washing and completing wells.

J. F. Inderdohnen and A. Noble. U.S.P. 2,274,479, 24.2.42. Appl. 22.7.39. Device for measuring pressures of flowing fluids irrespective of temperature.

J. M. Hartgering and C. M. Perkin. U.S.P. 2,274,601, 24.2.42. Appl. 1.7.39. Oil-well pumping unit using a walking beam with springs attaching the beam to opposite sides of the samson post. A. H. N.

Gas.

446.* Liquefied Petroleum Gas in 1941. Anon. *Chem. Met. Eng.*, February 1942, **49** (2), 125.—Estimated domestic use of liquefied petroleum gas in 1941 amounts to 221,880,000 gal., an increase of 65·5% over 1940, when 134,018,000 gal. were so consumed. On the basis of the most reliable information available, the number of new domestic users of liquefied petroleum gas increased by approximately 520,000 during the year. It is now estimated that there are a total of 1,645,000 users of liquefied petroleum gas in the domestic and small commercial classification.

One trend in refining technology relating to the manufacture of aviation gasoline which will have a pronounced effect on the available supply of butanes to the liquefied petroleum gas industry is the process of isomerization of normal butane into *iso*butane, with the *iso*butane then being converted into aviation gasoline by either the thermal or catalytic alkylation process. The demand for tremendous quantities of aviation

gasoline has greatly stimulated the installation of new large-capacity isomerization and alkylation plants, and plans for further expansion along these lines throughout the petroleum industry are well under way. A. H. N.

Cracking.

447.* Revised Cracking Technique Increases Octane Rating of Michigan Distillate. Anon. *Refiner*, February 1942, **21** (2), 43–44.—Early difficulties in cracking Michigan crude oil have been eliminated in recent plant designs. A typical plant and its operation, as well as results obtained therefrom, are described. A. H. N.

448. Patents on Cracking. Standard Oil Development Co. E.P. 543,215, 16.2.42. Appl. 28.12.39. Method of processing oils containing constituents unvaporizable under temperature conditions suitable for catalytic cracking treatment. The oils are processed to form lower-boiling hydrocarbons in the motor-fuel range by subjecting them to mild thermal cracking at temperatures of the order of 850° F. Products of this thermal cracking are separated into vapours of products boiling substantially below 800° F. and a heavy residue. The vapours are passed into contact with an active solid catalyst at a temperature suitable for the production of a high ratio of motor fuel to normally gaseous products.

L. C. Huff. U.S.P. 2,271,298, 27.1.42. Appl. 28.8.37. Conversion process which includes cracking hydrocarbon oil heavier than gasoline, fractionating the resultant vapours and returning fractions thus condensed to further cracking, whereby the vapours are separated into light gasoline fractions of satisfactory anti-knock value and a higher-boiling condensate. The light gasoline fractions are condensed and recovered, and the condensate subjected to reforming to increase the anti-knock value of the heavy gasoline fractions.

C. H. Angell. U.S.P. 2,271,610, 3.2.42. Appl. 31.8.38. Subjection of hydrocarbon oil to cracking conditions of temperature and pressure. Afterwards the resultant heated conversion products are removed from the conversion zone and a relatively heavy reflux condensate, a lighter condensate, a final distillate and gases separated therefrom. At least a portion of the gases are scrubbed with a portion of the lighter reflux condensate and the resultant enriched condensate stripped of the absorbed gaseous components.

W. L. Benedict. U.S.P. 2,271,617, 3.2.42. Appl. 25.5.39. A hydrocarbon oil-conversion process which comprises contacting the charging oil, with an active cracking catalyst to form a substantial quantity of gasoline and heavier products more refractory to catalytic cracking than the charging oil. The gasoline is separated from the heavier products, and at least a portion of the latter subjected in admixture with hydrogen, to the simultaneous action of a cracking catalyst, and a hydrogenating catalyst. In this way a substantial yield of gasoline is obtained from the heavier products.

H. S. Bloch and E. C. Lee. U.S.P. 2,271,618, 3.2.42. Appl. 30.9.38. Production of gasoline from hydrocarbon oils heavier than gasoline by contacting the oil at cracking temperature with a calcined mixture of the hydrogels of silica and vanadia. The mixture is substantially free of alkali metal ions.

E. R. Kanhofer. U.S.P. 2,271,645, 3.2.42. Appl. 22.1.40. Conversion of hydrocarbon oil by introducing into a fractionating zone and fractionating same, together with cracked products to form a gasoline-containing overhead product, a residual fraction containing unvaporized charging oil, and a condensate fraction boiling intermediate between the two. A powdered cracking catalyst is mixed with the intermediate condensate and the resultant product subjected to catalytic cracking conditions. Conversion products and admixed catalyst are introduced into the fractionating zone, thereby mixing the catalyst with the residual fraction. Afterwards residual fraction and catalyst are removed from the fractionating zone and subjected to independently controlled cracking operations. Products of this cracking process are separated into vapours and residue and the former passed to the fractionating zone. H. B. M.

Hydrogenation.

449. Patents on Hydrogenation. R. Leprestre. U.S.P. 2,271,017, 27.1.42. Appl. 10.5.38. Method of increasing the hydrocarbon content of hydrocarbon products by preparing an aqueous colloidal mixture of the base material. The mixture and a hydrogen carrier are injected simultaneously, at a pressure of 12,000–14,000 lb. per square inch, into a chamber within which a temperature of approximately 1000° F. is maintained. The base material and carrier are brought into direct impingement at a common point in the chamber, and the mixture circulated in contact with a catalyst. Thereafter the gaseous products from the catalytic reaction are cooled and condensed.

W. Herbert. U.S.P. 2,271,259, 27.1.42. Appl. 25.5.38. Catalytic conversion of gaseous mixtures, containing carbon monoxide and hydrogen, into hydrocarbons with catalysts adapted to form benzine oil and paraffin under atmospheric pressure.

H. B. Kipper. U.S.P. 2,274,204, 24.2.42. Appl. 4.5.40. Process for the dehydrogenation of hydrocarbons of a class consisting of the hydrocarbon gases above methane and delivered as waste gases from petroleum-oil cracking. The process includes subjection of the hydrocarbons to treatment with a mixture of oxygen and an inert gas. The oxygen is present in sufficient amount only to react substantially with all the liberated hydrogen. H. B. M.

Polymerization and Alkylation.

450. Patents on Polymerization and Alkylation. Standard Oil Development Co. E.P. 543,046, 9.2.42. Appl. 12.1.40. Production of normally liquid saturated hydrocarbons boiling within the gasoline range by reacting a mixture of hydrocarbons comprising both *iso*- and normal paraffins with a mono-olefin or a di-olefin, in the presence of an alkylation catalyst.

Standard Oil Development Co. E.P. 543,085, 10.2.42. Appl. 30.4.40. Improved process for the conversion of normal paraffins into *iso*paraffins with a metal halide Friedel–Crafts catalyst. Halide or boron is used as a catalyst activator.

A. R. Goldsby. U.S.P. 2,271,860, 3.2.42. Appl. 17.2.38. Manufacture of higher-boiling *iso*paraffins from low-boiling *iso*paraffins and olefins by subjecting a hydrocarbon fraction containing low-boiling *iso*paraffins, olefins, and normal paraffins to alkylating conditions. Normal paraffins are afterwards separated from the reaction products and isomerized to *iso*paraffins, which are then charged to the alkylation operation to increase the ratio of *iso*paraffins to olefins in the reaction mixture and to produce further quantities of higher-boiling *iso*paraffins.

V. N. Ipatieff and H. Pines. U.S.P. 2,273,041, 17.2.42. Appl. 3.7.39. An alkylation process which comprises reacting *iso*butene with *iso*butane in the presence of aluminium chloride and hydrogen chloride at a temperature above 0° C. and under sufficient pressure to maintain a substantial portion of the hydrocarbons in liquid phase.

V. N. Ipatieff and H. Pines. U.S.P. 2,273,042, 17.2.42. Appl. 3.7.39. An alkylation process which comprises reacting normal butene with *iso*butane in the presence of aluminium chloride and hydrogen chloride at a temperature above 0° C. and under sufficient pressure to maintain a substantial portion of hydrocarbons in liquid phase.

V. N. Ipatieff and H. Pines. U.S.P. 2,273,043, 17.2.42. Appl. 3.7.39. An alkylation process which comprises reacting propene with *iso*butane in the presence of aluminium chloride and hydrogen chloride at a temperature above 0° C. and under sufficient pressure to maintain a substantial portion of the hydrocarbons in liquid phase. H. B. M.

Synthetic Products.

451.* Mobilizing Petroleum Hydrocarbons. G. F. Fitzgerald. *Chem. Met. Eng.*, March 1942, **49** (3), 83–87.—The effects of the war on various synthetical processes using hydrocarbons as raw materials are discussed, particularly the situation of butadiene and fighting-grade aviation gasoline. Statistical data are given. The rubber situation is discussed, and it is noted that about a year and a half is the maximum time allowable to improve the situation.

Acetylene production from petroleum is under development by research workers at the University of Texas. They report that it has been made experimentally from propane, but has not yet reached the commercial stage. Existing facilities for the synthesis of butadiene from petroleum gases are being rapidly augmented. Typical of the new facilities is a 5000-ton/year unit which went into production late in 1941. Several more plants are under construction, but details must be considered as military secrets at this time.

Isomerization, polymerization, and catalytic cracking are briefly discussed. It is concluded that all industry is being mobilized in the States. Demand for synthetic rubber has put an unexpected burden on the petroleum industry. The production of 100-octane gasoline must be rapidly increased. Sufficient *iso*butane, butadiene, high-octane blending agents, and other strategic petroleum derivatives must be provided to carry on the war production programme. Existing capacities for these materials must be expanded 300, 400, and in some cases even 500% to meet the demand of the armed forces. A. H. N.

Refining and Refinery Plant.

452.* Decoking Petroleum Residues. J. S. Swearingen, M. R. Morrow, and B. Jones. *Refiner*, February 1942, **21** (2), 31–35.—An historical review of the process is given. Shell-still methods were followed by the continuous tube-still heater methods. The charge is heated by continuous charging of the reaction chamber through a tube-still heater, the oil being allowed to stand in the reaction chamber and go to coke and distillate due to its own sensible heat. Obviously, there should be more than one chamber in parallel, to allow time for cleaning out the coke. The charge may also be heated by contact with a hot stream in the cracking unit where the two enter the reaction chamber together. Variations of these methods with even the inclusion of re-circulation of a portion of the residuum are possible, and necessary to suit particular conditions.

These methods of heating are particularly feasible in view of the fact that the residuum is available in a continuous stream at about 850° F. The development of these methods was apparently delayed until cracking-plant control was perfected, and made sufficiently automatic that additional continuous apparatus also requiring control could be attached without unduly complicating and hampering the whole operation.

The methods of coke removal have also been improved, with three methods predominating—namely, cable pulling, drilling, and the hydraulic method. The cable-pulling method consists of filling the coke-chamber with layers of steel cable in spirals. When the chamber has been filled with coke, the removal of the cable by means of a winch located on the end of the drum ploughs up the coke so that it practically falls out. The disadvantages are the labour requirement, the presence of wire in the choke, and the time required (8–15 hrs. or longer).

The drilling method is, as the name implies, the removal of the coke by a series of drilling operations. The hydraulic method involves the use of high-pressure (1200 lb./sq. in.) jets of water, which literally wash the coke out of the drum.

A study of the effects of coking conditions and of the type of residuum on the yields of products and on the properties of the liquid products is apparently not recorded anywhere in the literature, and so constitutes an important part of the present work, wherein the effect of temperature and period of detention and the type of charging stock were varied. In the light of these data a method and a large laboratory apparatus for carrying out the reaction under optimum conditions is described and the results are given. A. H. N.

453.* Sub-Cooling Absorption Oil in Two Phases. Anon. *Refiner*, February 1942, **21** (2), 38.—The principal application of chilling is in the base of the absorbers, while the secondary application is after the absorption oil has passed through the atmospheric sections in the cooling tower. Since the greatest rise in temperature in the absorbers is at the first contact between the gas and the oil, these absorbers are equipped with two tube bundles each, located immediately above the connection through which

the compressed gas enters the columns. The oil which is chilled in the second phase enters the top of the absorbers above the bubble trays at a temperature sufficiently low to absorb and retain propane and heavier fractions extracted in the absorption process. Details of the plant are briefly described.

The fall in temperature of the oil and gas in the base of the absorbers is controlled by gate valves in the vapour lines from the hair-pin chillers, which are set to place the necessary back pressure on the butane to accelerate or reduce the rate of vaporization of the butane. The line carrying the butane vapours from the absorber chillers is insulated to prevent loss of refrigeration before reaching the butane vapour-to-absorption-oil cooler.

The vapour-to-absorption-oil cooler is made in the plant shops from a 40-ft. section of 24-in. pipe, with 212 ¾-in. tubes inside, and connected for oil-flow through the tubes and butane in the shell. Since most of the butane is expanded to vapour in the two pairs of hair-pin bundles in the absorbers, the material entering the vapour-to-oil exchanger is a mixture of vapours and liquid, which is reduced in pressure with a pilot-operated controller at the entrance to the exchanger. The piping is arranged so that the refrigerant enters the exchanger at the base and passes to the suction line of the compressor at opposite end through a top connection. With the reduced pressure in the shell of the exchanger and the direction of flow, a combination of flooded—at one end—and vapour chilling is obtained, sufficient to reduce the temperature of the oil from summer conditions of 92° F. in, and 80° F. out.

With an oil temperature at the inlet of the absorbers above the top bubble-tray running around 80° F. during summer, desired fractions are prevented from passing to the residue line in the stripped gas, and by controlling the temperature of the oil and gas in the base of the columns, fractions are retained in the oil as it leaves the columns to obtain the necessary composition of the raw gasoline for manufacturing any grade of natural gasoline and liquefied petroleum gases. A. H. N.

454.* Welding Grooves in Refinery Practice. W. L. Archer. *Refiner*, February 1942, **21** (2), 48.—A detailed study of the importance of grooves in welding refinery equipment is made. Dimensions and practical hints are given in full. A. H. N.

455. Patents on Refining and Refinery Plant. E. I. Du Pont de Nemours. E.P. 543,292, 18.2.42. Appl. 15.5.40. Process for inhibiting deterioration in colour of viscous petroleum oils. Organic compounds of the type of Schiff's bases are incorporated with the oils.

C. M. Ambler. U.S.P. 2,271,882, 3.2.42. Appl. 9.8.39. Purification of used hydrocarbon oils by mixing with the oil an aqueous alkaline reagent. Afterwards the mixture is subjected to an evaporating operation to remove a substantially large part of the water and concentrate the reagent. Finally alkaline reagent and impurities are separated from the oil by subsidence.

W. L. Benedict and J. E. Ahlberg. U.S.P. 2,273,012, 17.2.42. Appl. 30.1.39. Method of removing impurities from hydrocarbon oil by treating it under refining conditions with hydrochloric acid and a calcined mixture of a silica hydrogel and a heavy metal hydrogel.

W. O. Heilman. U.S.P. 2,273,104, 17.2.42. Appl. 24.2.41. Method of removing mercaptan compounds from oils boiling above 250° F. The feed-oil is segregated into a relatively low-boiling fraction and a relatively high-boiling fraction. The low-boiling fraction is treated in a primary contacting zone with an alkali metal hydroxide solution to remove mercaptan compounds. The treated oil is then separated from the solution and the respective streams of oil and solution are removed from the contact zone. The relatively high-boiling fraction is treated in a secondary contacting zone with the separated alkali metal hydroxide solution to remove mercaptan compounds. Finally the high-boiling fraction is separated and combined with the low-boiling fraction to make the final product.

F. W. Schumacher. U.S.P. 2,273,147, 17.2.42. Appl. 21.9.38. Method of decolorizing petroleum oils in a distillation tower. Constituents of the oil are with-

drawn from a point below the feed inlet to the tower and a clay slurry formed with the fraction withdrawn. Afterwards the clay slurry is reintroduced into the tower at a point below that at which the constituents were previously withdrawn.

W. A. Schulze. U.S.P. 2,273,224, 17.2.42. Appl. 3.1.39. Method of improving the quality of straight-run and cracked gasoline stocks containing organic sulphur impurities. The mixed vapours of the straight-run and cracked gasoline stocks are passed over a catalyst of absorbent clay at a temperature between 500° and 1000° F., a pressure between atmospheric and 100 lb., and a flow-rate of 1–100 liquid volumes per hour per volume of catalyst. Temperature control is maintained by the addition of an inert gas at a temperature above that of the gasoline stock vapours to supply a portion of the endothermic heat of reaction.

J. Happel, Jr., and D. Warren. U.S.P. 2,273,263, 17.2.42. Appl. 13.11.39. Method of sweetening oil fractions containing sour sulphur compounds by contacting with an oil-soluble lead naphthenate and with added reagent sulphur in the absence of water and at normal atmospheric temperature. Afterwards lead sulphide formed by the reaction is removed from the oil.

A. Szayna. U.S.P. 2,273,299, 17.2.42. Appl. 8.10.38. Method of desulphurizing hydrocarbon oils by passing through a porous contact mass having an extended surface comprising free metal of the class consisting of nickel, cobalt, and iron, and having sulphur distributed throughout the surface. After the mass has taken up a substantial amount of additional sulphur from the oil, at least part of it is segregated and the additional sulphur removed by oxidation. The oxidation process is terminated while there still remains sufficient sulphur in the mass substantially to poison its catalytic activity.

J. W. Poole, U.S.P. 2,273,661, 17.2.42. Appl. 27.1.38. Method of refining a mineral oil containing lubricating oil by selective action of solvents substantially liquid at usual atmospheric conditions of temperature. Under such conditions none of the solvents will approach by itself maximum selective efficiency. A blend of crotonaldehyde and another solvent which is sparingly solvent in the oil is used.

R. P. Dunmire. U.S.P. 2,273,846, 24.2.42. Appl. 25.8.41. Method of removing impurities from used mineral oils and mineral waxes. The used material is mechanically mixed with a solid adsorbent material in a sealed container to adsorb high-boiling-point impurities. The mixture is then heated under vacuum at a temperature between 50° and 150° F. to drive off water and low-boiling-point impurities. Finally the adsorbent material with its impurities is separated from the mineral substance under treatment.

F. E. Wellman. U.S.P. 2,273,915, 24.2.42. Appl. 18.3.38. Process for desalting crude oil or fractions thereof by contacting with water in a continuous system having a settling chamber. A brine concentration is built up by contacting and re-contacting of incoming crude oil with water precipitated from the crude oil in the settling chamber, and maintained by the introduction of water into the system and release of excess brine from the system. H. B. M.

Analysis and Testing.

456.* Practical Corrosion Tester for Chemical Engineers. M. H. Heeren. *Chem. Met. Eng.*, February 1942, **49** (2), 126–127.—Principal factors in corrosion are briefly reviewed:—1. Temperature: (*a*) Corrosion reactions are accelerated with increased temperature, as are chemical reactions in general. (*b*) An increase in temperature can result in increased ionization and rates of diffusion. (*c*) Local differences in temperature may set up electrolytic cells acting as concentration cells. 2. Moisture: (*a*) Serious damage by corrosion to metal parts commonly takes place only if the metal surface is moist. 3. Galvanic action: (*a*) When two dissimilar metals are coupled and placed into an electrolyte, corrosion takes place. (*b*) When metal is placed into a solution in which the solute is stratified in different concentrations, corrosion of the metal takes place.

The method uses an endless chain from which specimens are suspended, the chain moving continually, and thus either dipping the specimens in trays full of the corroding liquids or exposing them to air draught, radiant heat, or a spray. The apparatus is flexible, and whilst there are many cases for which this apparatus is inadequate, its variability answers a large portion of the ordinary laboratory demands, and its agreement with actual field results is most gratifying. While the unit was designed primarily to determine the collective effects of corrosive conditions on metals, it has also been used advantageously in weathering tests on non-metals, such as paint, plastics, etc. In the case of paints, the radiant-heat chamber should be equipped with a source of ultraviolet light.

The selection of specimens for test naturally is governed by the types of materials to be employed in the construction of a plant or piece of equipment. In much of the current work at the Research Foundation, steel, cast iron, brass, copper, and aluminium are used. The specimen strips, approximately $\frac{1}{4}$ in. $\times$ 3 in. used both individually and coupled dissimilarly, are suspended from the chain by means of glass hooks.

Preparation of the specimens consisted of careful cleaning by means of emery paper, followed by washing in alcohol and ether and weighing. The duration of a test is generally 336 hr. (2 weeks) continuous operation. On completion of the test the specimens are rinsed in distilled water, alcohol and ether, and re-weighed. A specific case is studied in some detail. A. H. N.

457.* Development of a Capillary Viscometer. A. H. Nissan. *J. Inst. Petrol.*, March 1942, **28** (219), 41–56.—Detailed description of a capillary viscometer adapted to measure viscosities between 10 and 750 poises is given. The errors in the measurements of temperature, pressure, rate of flow, and in the constancy of head across the viscometer are analysed. The total maximum error is shown to be of the order of 2%. A. H. N.

Motor Fuels.

458. Patents on Motor Fuels. J. K. Roberts. U.S.P. 2,271,095, 27.1.42. Appl. 29.12.37. Conversion of higher-boiling hydrocarbon oil into lower-boiling hydrocarbons by heating a crude-oil residual stock to cracking temperature and passing the heated products to a coking zone maintained at a coking temperature. In this way vapours are separated from coke residue. These are then fractionated to separate heavy gas-oil from light gas-oil, and the former afterwards passed through a viscosity breaking zone, wherein it is maintained under superatmospheric pressure and relatively high temperature conditions. Thus is produced a relatively high yield of intermediate constituents suitable for further cracking to produce gasoline constituents.

R. F. Ruthruff and C. F. Feuchter. U.S.P. 2,271,096, 27.1.42. Appl. 29.12.37. Treatment of crude residual charging stock in a similar manner to that described in U.S.P. 2,271,095.

R. F. Ruthruff and J. K. Roberts. U.S.P. 2,271,097, 27.1.42. Appl. 29.12.37. Treatment of a relatively heavy hydrocarbon oil in a similar manner to that described in U.S.P. 2,271,095.

C. L. Thomas and J. E. Ahlberg. U.S.P. 2,271,317, 27.1.42. Appl. 6.1.41. Conversion of hydrocarbon distillate heavier than gasoline into substantial yields of gasoline. The distillate is subjected under cracking conditions to contact with a catalyst produced by separately precipitating hydrated aluminium oxide and hydrated silicon dioxide containing alkali metal ions. The precipitated materials are freed of alkali metal ions by treating with a solution of a salt of magnesium, and the purified materials mixed in the wet condition. Finally, they are dried to remove a major portion of the total water content.

C. L. Thomas and J. E. Ahlberg. U.S.P. 2,271,318, 27.1.42. Appl. 6.1.41. Conversion of distillates heavier than gasoline into substantial yields of gasoline by sub-

jecting the distillate under cracking conditions to contact with a catalyst produced by separately precipitating hydrated aluminium oxide and hydrated silicon dioxide containing alkali metal ions. The precipitated materials are freed of alkali metal ions, by treating with a solution of a salt of manganese, and the purified materials mixed in the wet condition. Finally, they are dried to remove a major portion of the total water content.

C. L. Thomas and J. E. Ahlberg. U.S.P. 2,271,319, 27.1.42. Appl. 6.1.41. Conversion of distillates heavier than gasoline into substantial yields of gasoline by subjecting the distillate under cracking conditions to contact with a catalyst produced by separately precipitating hydrated aluminium oxide and hydrated silicon dioxide containing alkali metal ions. The precipitated materials are freed of alkali metal ions by treating with a solution of a salt of cerium, and the purified materials mixed in a wet condition. Finally, they are dried to remove a major portion of the total water content.

S. Shappirio. U.S.P. 2,272,134, 3.2.42. Appl. 13.3.42. Preparation of a liquid hydrocarbon motor fuel containing a minor proportion of a metallo-organo diazo-compound.

A. Szayna. U.S.P. 2,273,298, 17.2.42. Appl. 23.9.38. Production of motor fuel which is substantially free from sulphur by heating a hydrocarbon oil to cracking temperature, and passing the heated oil, in vapour phase and in admixture with 1–5% by weight of hydrogen, through a body of contact material comprising a metal of the group consisting of iron, nickel, cobalt, and copper. The contact material is in a special state of activity, so that its hydrogenating and desulphurizing power is less than maximum throughout the body. In this way absorption of sulphur from the hydrocarbon oil is effected. Thereafter flow of the oil-vapour through the body is discontinued and the body regenerated. H. B. M.

Chemistry and Physics.

459. Structure of Vinyl Co-polymers. F. T. Wall, *J. Amer. chem. Soc.*, 1941, **63**, 1862–1866.—Vinyl chloride and vinyl acetate are taken as a typical pair of substances capable of undergoing co-polymerization. A theoretical treatment on the composition of co-polymers is given. There is also a consideration of the intramolecular distribution of monomer units within the polymer chains. E. H. W.

460. Alkyl-Substituted Hexa-arylethanes. XL. Symmetry and Steric Effects as Factors in Dissociation. C. S. Marvel, J. F. Kaplan, and C. S. Himel. *J. Amer. chem. Soc.*, 1941, **63**, 1892–1896.—Continuing previous work, these authors have prepared various di-, tetra-, and hexa-alkyl substituted hexa-arylethanes and calculated their per cent. dissociation by magnetic susceptibility measurements.

From the results obtained the following conclusions were reached. *ortho*-Alkyl substitution greatly increases the degree of dissociation. The symmetry of the ethane seems to be the next important factor after the steric or *ortho* effect. Also *meta*-alkyl groups promote dissociation more than *para*-alkyl groups. E. H. W.

461. Photolysis of Ketene and the Structure of Methylene. M. Burton, T. W. Davis, A. Gordon, and A. Taylor. *J. Amer. chem. Soc.*, 1941, **63**, 1956–1960.—The photolysis of ketene has been studied over a restricted range of temperature in the presence of varying concentrations of nitric oxide and ethylene. Evidence for the structure of methylene as a stable molecule or as a free radical is discussed. E. H. W.

462. Resonance-Energies of Unsaturated and Aromatic Molecules. G. W. Wheland. *J. Amer. chem. Soc.*, 1941, **63**, 2025–2027. Following the paper by Mulliken and Rieke (*ibid.*, 1941, **63**, 1770) a modification is suggested here on the calculation of resonance energies of molecules and free radical resonance energies of radicals. The results obtained with a number of unsaturated and aromatic hydrocarbons, and also a series of free radicals, are compared with experimental thermal data and earlier valence bond and molecular orbital calculations. E. H. W.

463. Structure of Alicyclic Compounds. J. G. Astron, S. C. Schumann, H. L. Fink, and P. M. Doty. *J. Amer. chem. Soc.*, 1941, **63**, 2029–2030.—These authors have compared the entropies of *cyclo*pentane obtained from thermal data down to 11·1° K. with those obtained from molecular and spectroscopic data based on three ring models. The experimental data they obtained are shown to agree more nearly with a non-planar model with one atom out of the plane, the other models being a planar model and a non-planar model with two atoms out of the plane.

Similar comparisons made with methyl*cyclo*pentane led to the same conclusion. *cyclo*Hexane gave a symmetry number of $\sigma = 6$, as expected. Their results also agreed with those of Beach (*J. Chem. Phys.*, 1941, **9**, 54), from the electron diffraction by tetrahydrofuran, which led also to a non-planar configuration. E. H. W.

464. Dehydration of Tertiary Carbinols Containing the Neopentyl Group. F. C. Whitmore and E. Rohrmann. *J. Amer. chem. Soc.*, 1941, **63**, 2033–2035.—This paper describes the dehydration with anhydrous copper sulphate of diethylneopentyl carbinol, giving 90% of 2 : 2-dimethyl-4-ethyl-4-hexene (dehydration from ethyl group), and less than 10% of 2 : 2-dimethyl-4-ethyl-3-hexene (dehydration from neopentyl group). Similarly, methyl *n*-butylneopentyl carbinol gave over 80% of 2 : 2-dimethyl-4-methyl-4-octene (dehydration from *n*-butyl group), and about 10% of 4 : 4-dimethyl-2-*n*-butyl-1-pentene (dehydration from methyl group), and only a trace of 2 : 2-dimethyl-4-methyl-3-octene (dehydration from neopentyl group). This work confirms the difficulty with which the neopentyl group will enter into a dehydration reaction. E. H. W.

465. Polymerization of Olefins. V. The Isomers in Tri*iso*butylene. F. C. Whitmore, C. D. Wilson, J. U. Capinjola, C. O. Tongberg, G. H. Fleming, R. V. McGrew, and J. N. Cosby. *J. Amer. chem. Soc.*, 1941, **63**, 2035–2041.—The structures and ratio of the various isomers of tri*iso*butylene are of importance to the work being done on polymerization, hence the fractionation and separation of these isomers was attempted.

Partial separation into lower- and higher-boiling fractions, in the ratio 9 : 1, was accomplished by repeated fractionations. The lower-boiling fractions of N^{20}D 1·4300 were shown to be 2 : 2 : 4 : 6 : 6-pentamethyl-3-heptene (I) and 2-neopentyl-4 : 4-dimethyl-1-pentane,—*unsym.*-dineopentylethylene (II) in the ratio of 2 : 3. The slightly higher-boiling fraction of N^{20}D 1·4310–5 could not be completely separated, but was apparently mainly the higher-boiling geometric isomer of I.

The higher-boiling isomers were shown to consist of 2 : 4 : 4 : 6 : 6-pentamethyl-1-heptene and 2 : 4 : 4 : 6 : 6-pentamethyl-2-heptene in about equal quantities. No evidence was found for the presence of 2 : 4 : 4-trimethyl-3-*t*-butyl-2-pentene, as reported by other workers. E. H. W.

466. Reaction of Olefins with Solid Cuprous Halides. E. R. Gilliland, H. L. Bliss, and C. E. Kip. *J. Amer. chem. Soc.*, 1941, **63**, 2088–2090.—The reactions of ethylene, propylene, and *iso*butylene with solid cuprous halides was described previously (*ibid.*, 1930, **61**, 1960). The paper now presented continues that work, and shows that butadiene, acetylene, and isoprene react with solid cuprous halides in a similar manner. The former two give compounds containing 1 mole of olefin with 2 moles of cuprous halide. The reaction with isoprene, however, is not so definite.

No reaction of amylene or *cyclo*pentadiene with solid cuprous chloride could be detected. E. H. W.

467. Synthesis of 5-Methoxy-10-methyl-1 : 2-benzanthracene and Related Compounds. M. S. Newman and P. H. Wise. *J. Amer. chem. Soc.*, 1941, **63**, 2109–2111.—Continuing a study of the carcenogenic action of 10-methyl-1 : 2-benzanthracene produced by the introduction of functional groups at various positions, these authors have prepared 5-methoxy-10-methyl-1 : 2-benzanthracene (VI) and 5 : 9-dimethoxy-10-methyl-1 : 2-benzanthracene (VII). Tests on VII were still being conducted, while VI had shown no carcenogeneric activity on mice in 10 months, after subcutaneous injection. E. H. W.

468. Refractive Index of Paraffins in Terms of the Number and Frequency of the Dispersion Electrons. S. S. Kurtz, Jr., and M. R. Lipkin. *J. Amer. chem. Soc.*, 1941, **63**, 2158–2163.—Previous work on hydrocarbons has shown a direct relation between the number of dispersion electrons (calculated by the Sellmeier–Drude equation) and the number of formula bonds. In this paper it was assumed that all valence electrons have the same effect in refracting light; calculation shows this to be only approximately true. Using the above equation, the number and frequency of the dispersion electrons were calculated. It was also shown that the frequency is linear with the density. Using these figures, an equation was developed for the calculation of the refractive indices of paraffins at any wave-length of light and at any temperature and pressure, providing the corresponding density is known. The effect of temperature and pressure on these calculations is discussed. A comparison of the refractive indices calculated by this method and by the Lorenz–Lorentz equation using the Eisenlohr constants is given. The authors emphasize the need for further research along indicated lines. E. H. W.

469. Polymerization of Olefins. VI. The Dimers Obtained from Tetramethylethylene. *Preliminary Paper.*—F. C. Whitmore and P. L. Meunier. *J. Amer. chem. Soc.*, 1941, **63**, 2197–2199.—Tetramethylethylene has been polymerized with 80% sulphuric acid at 0° C. The results of Brunner and Farmer (*J. chem. Soc.*, 1937, 1039) were confirmed and extended. The chief products of the dimer were: 2 : 2 : 3 : 5 : 6-pentamethyl-3-heptene (about 50%), 2 : 2 : 4 : 6 : 6-pentamethyl-3-heptene (about 25%), 2 : 3 : 4 : 6 : 6-pentamethyl-2-heptene (about 10%), and 0·2% 1 : 1-dineopentylethylene. All the observed results corresponded to rearrangements before and after the union of the parts of the dimers. Existing theories of polymerization do not explain the formation of the dimers, but these results are in agreement with a combination of polymerization and rearrangement theories held by the authors. E. H. W.

470. Polymerization of Olefins. VII. Isolation and Oxidation of 1 : 1-Dineopentylethylene. F. C. Whitmore and J. O. Surmatis. *J. Amer. chem. Soc.*, 1941, **63** 2200–2201.—1 : 1-Dineopentylethylene was readily obtained in 15–20% yields from the oxidation of crude tri*iso*butylene. Oxidation of the product was difficult, thus confirming previous work, but with chromic acid mixture at 50–60° C. about 25% dineopentyl acetic acid and about 50% of unchanged olefin were obtained. E. H. W.

471. *cis-* and *trans-* Forms of 2 : 5-Dimethyl-3-hexene, 2 : 5-Diol Correction. I. Zalkind. *J. Amer. chem. Soc.*, 1941, **63**, 2282.—Notice is called to an investigation of Bourgel's crystals by I. Zalkind and S. Bukhovets (*J. Gen. Chem. USSR.*, 1937, **7**, 2417; *Chem. Abs.*, 1938, **32**, 2086). It is pointed out that crystals of Bourgel are not ethylenic, but are an acetylenic derivative—namely, 2 : 5-dimethyl-3-hexine, 2 : 5-diol. Hence the *trans*-form of 2 : 5-dimethyl-3-hexane-2 : 5-diol could not have been obtained from the above crystals by J. R. Johnson and O. H. Johnson (vide "Rearrangement of Unsaturated 1 : 4-Glycols, II," *J. Amer. chem. Soc.*, 1940, **62**, 2615). E. H. W.

472. *cis-* and *trans-* Forms of 2 : 5-Dimethylhexene-2 : 5-Diol Correction. J. R. Johnson. *J. Amer. chem. Soc.*, 1941, **63**, 2282.—Recent work by this author confirms the work of Zalkind and Bukhovets, and in consequence a correction is necessary for the experimental data given on page 2619 in the paper by Johnson and Johnson (see preceding abstract for references). The correction is as follows (referring to page 2619): "The dichloride obtained by the action of hydrochloric acid should be designated as 2 : 5-dichloro, 2 : 5-dimethyl-3-hexine, and the product of dehydration as 2 : 5-dimethyl hexadiene, 1 : 5-ine-3. The conclusions relating to the relative reactivity of the alleged *cis-* and *trans-* forms should be stricken from the literature." E. H. W.

473. Nitrogen Compounds in Petroleum Distillates. XXIII. Isolation of 2 : 6-Dimethylbenzo-(*h*) Quinoline (I) and 2 : 4-Dimethylbenzo-(*h*) Quinoline (II) from California Petroleum. L. M. Schenck and J. R. Bailey. *J. Amer. chem. Soc.*, 1941, **63**,

2331–2333.—The benzo(*h*)quinoline homologues I and II were isolated for the first time from natural sources by accumulative extraction of California gas-oil bases in the range 355–365° C. with hydrochloric acid and chloroform. The structure of these was deduced and confirmation was provided by synthesis. R. D. S.

474. Heat Capacity of Gaseous Paraffin Hydrocarbons, Including Experimental Values for *n*-Pentane and 2 : 2-Dimethylbutane. K. S. Pitzer. *J. Amer. chem. Soc.*, 1941, **63**, 2413–2418).—A new flow-type calorimeter capable of measuring both the heat capacity of the gas and the heat of vaporization was devised for this research. Flow of vapour was obtained by electrical evaporation of the liquid at a constant rate, and the condensed vapour was returned to the vaporizing chamber as liquid at its boiling point, so that a continuous cycle was established The results obtained on this instrument were found to agree with the heat capacity of carbon tetrachloride vapour as calculated statistically. For *n*-pentane and 2 : 2-dimethylbutane, results are reported of the measurements of heats of vaporization and heat capacities from boiling point to about 450° K. The statistical calculations in this paper show that the barriers to internal rotation in *n*-butane and *n*-pentane are probably about 3600 cal. per mole, instead of 30,000 and 16,000, respectively, which have been previously proposed. A general empirical equation has been evolved for all gaseous paraffins above ethane, both normal and branched; where n is the number of carbon atoms and t is in degrees Centrigrade: $C_p^0 = 5{\cdot}65n - 0{\cdot}62 + t(0{\cdot}0111n + 0{\cdot}0158)$.
R. D. S.

475. Thermodynamics of Branched-Chain Paraffins. The Heat Capacity, Heats of Fusion and Vaporization and Entropy of 2 : 3 : 4-Trimethylpentane. K. S. Pitzer and D. W. Scott. *J. Amer. chem. Soc.*, 1941, **63**, 2419–2422.—This paper reports the results of measurements of the thermodynamical constants of 2 : 3 : 4-trimethylpentane. A simple semi-empirical formula is suggested for calculating the entropies of the heavier branched-chain paraffins as follows:

$$S = Sn + R\ln 2 + R\ln(I/\sigma_e\sigma_i) - 3{\cdot}5B$$

where I, σ_e and σ_i are respectively the number of isomers included (2 for a racemic mixture), the symmetry number for external rotation in the carbon skeleton; and B is the number of chain branchings. The factor $R\ln 2$ arises because the normal paraffins all have the external symmetry number two. Sn is the entropy of the normal paraffin isomer at the temperature desired, and may in the case of the gaseous normal paraffins above butane, be represented by the sample equation $Sn = 9{\cdot}13n + 37{\cdot}62$ cal. per degree mole, where n is the number of carbon atoms. It is claimed that the combination of the formula for entropies with the sample formula for heat capacities, reported in the preceding abstract, should constitute a convenient method for thermodynamic calculations. R. D. S.

476. Dehydrogenation of Normal Heptane and *cyclo*Hexane on Cerium, Vanadium, and Thorium Oxide Catalysts. R. A. Briggs and H. S. Taylor. *J. Amer. chem. Soc.*, 1941, **63**, 2500–2503.—In the authors' examinations of the dehydrocyclization of normal heptane on chromium oxide catalysts, data have been collected on the aromatizing properties of the oxides of vanadium, thorium, and cerium, and on the influence of temperature, of mode of preparation, of depositions on supports, and of reaction feed rate. It was found that the order of aromatization activity was vanadium oxide, ceria, thoria. While none of these catalysts was as efficient as chromium oxide, vanadium oxide was comparable with chromium oxide. Thoria was found to be a poor aromatization catalyst, but possessed dehydrogenating activity. R. D. S.

477. Preparation of Some *p*-Dialkylbenzenes. C. E. Welsh and G. F. Hennion. *J. Amer. chem. Soc.*, 1941, **63**, 2603–2604.—The authors report the preparation of *p*-dialkylbenzenes from mono-alkylbenzenes and normal primary alcohols in the presence of boron fluoride and phosphorus pentoxide. Alcohols between C_4 and C_{12} give the best reactions. This method produces higher yields than direct dialkylation of benzene. R. D. S.

478. Viscosity Function. III. Complete Viscosity Range. E. P. Irany. *J. Amer. chem. Soc.*, 1941, **63**, 2611–2617.—In the first paper of this series (*ibid.*, 1938, **60**, 2106–2115; *J. Instn Petrol. Tech.*, 1938, **24**, Abstr. No. 1425) there was deduced the "ϕ scale," which provides linear representation of the relationship between viscosity and volume (dilution) and applies to all ideal (*i.e.*, non-associated or non-dissociated) mixtures. It was further deduced that the viscosity–temperature relationship could also be represented by the ϕ scale, and that therefore the laws governing viscosity relative to volume and viscosity relative to temperature are identical. In addition, it was shown that viscosity relative to pressure could be represented linearly by a separate function, the π scale. The present paper reports the extension of the scales in the regions of extremely high and extremely low viscosities. It is pointed out that the process of the extension does not merely call for the further application of the same graphical technique as before, but that it must be shown first that the fundamental law exists and can be expressed throughout the whole range of the liquid state. However, when the extremes of the liquid state are approached, the criteria of ideality (calorimetric, gravimetric, or cryoscopic evidence) become less sensitive, and standards of ideality must be based on evidence supplied by the existing scale. For example, a system comprising mixtures of liquid of widely dissimilar viscosities may be represented in part on the existing ϕ scale, and if that portion of the system within the range of the scale is linear, the system is, by hypothesis, ideal; so that those portions of system outside the existing scale provide new fixed points for the extension of the ϕ scale. In a similar way the temperature scale can be extended. Investigation of the low-viscosity range on pure hydrocarbons reveals the gradual divergence of the pure temperature scale from the mixture scale, and it has been found necessary to abandon the postulation of the identity of the temperature and dilution laws. The ϕ scale is now reserved for the mixture function, and the temperature function is designated by θ. Factors are given which allow the construction of any section of the two scales. General equations of the exponential type normally used for the representation of the viscosity–temperature function would seem to be of only limited validity, since they diverge from the θ scale in approaching the critical region. The π scale, or viscosity-pressure function, is extended by a method similar to that used on the ϕ scale. The acceptance of extended fixed points is made if all isotherms are linear and converge to a common point of intersection, the abscissa of which represents the internal pressure of the liquid. These investigations reveal that, unlike the lower aliphatic hydrocarbons, many mineral lubricating oils are non-ideal and deviate from the ϕ scale, due, possibly, to the accumulation of large molecules of structure groups. Most American paraffinic oils are non-ideal, as are poly*iso*butenes, but naphthenic oils have ideal functions, although the latter do not appear to give conclusive linearity on the π scale. The π scale for paraffinic oils is tentatively accepted as correct, and approaches a purely logarithmic function in the higher viscosity levels. The internal pressure of paraffinic oils seems to be higher than that of the naphthenic type. The three viscosity functions, ϕ, θ, and π, provide the most extensive empirical evidence to test the validity of mathematical formulations of the viscosity functions. R. D. S.

479. Common Basis of Intramolecular Rearrangements. VIII. Formation of *cyclo*Propanes from Monohalides and Sodium. II: Formation of 1 : 1 : 2-Trimethyl*cyclo*propane from 1-Chloro-2 : 2-dimethylbutane. F. C. Whitmore and T. P. Carney. *J. Amer. chem. Soc.*, 1941, **63**, 2633–2635.—The authors report the formation of neohexane (2 : 2-dimethylbutane), 29%; 1 : 1 : 2-trimethyl*cyclo*propane 13%, and *tert.*-butylethylene, 8% from the reaction between sodium and 1-chloro-2 : 2-dimethylbutane. The mechanism is probably bimolecular. No 1-methyl-1-ethyl*cyclo*propane was detected, and only a small amount of the coupled products 3 : 3 : 6 : 6-tetramethyloctane could be detected, which provides further evidence that the rearrangements accompanying the dehydration of *tert.*-amyl carbinol to give 2-methyl- and 3-methyl-2-pentenes do not occur by a free radical mechanism. R. D. S.

480. Reduction of Multiple Carbon–Carbon Bonds. III. Further Studies on the Preparation of Olefins from Acetylenes. K. N. Campbell and L. T. Eby. *J. Amer. chem. Soc.*, 1941, **63**, 2683–2685. In this paper are recorded the reduction of dialkylacetylenes, (1) to the *cis*- forms of 2-hexane and 2-octene by catalytic hydrogenation

and (2) to the *trans*- forms by sodium-liquid ammonia. Method (2) was applied to monoalkylacetylenes for the successful production of 1-alkenes. The advantage of the sodium-liquid ammonia method is that reduction stops at the olefin stage without contamination by saturated hydrocarbons. Similarly both dimethylethynylcarbinol and dimethylhexynylcarbinol were smoothly reduced to the corresponding olefinic carbinols without cleavage into ketones. The effect of the position of the double bond on the physical constants of straight-chain hexenes and octenes is discussed.
R. D. S.

481. Heats of Combustion and of Formation of the Nine Isomeric Heptanes. G. F. Davies and E. C. Gilbert. *J. Amer. chem. Soc.*, 1941, **63**, 2730–2732.—The thermochemical data at 25° C. in the liquid state are tabulated. R. D. S.

482. Changes in the Pressure of Monomolecular Films of Stearic Acid due to Added Drops of Benzene. E. R. Washburn, L. F. Transue, and T. J. Thompson. *J. Amer. chem. Soc.*, 1941, **63**, 2742–2745.—The authors have measured the times of evaporation of small uniform drops of benzene added to monomolecular films of stearic acid in different states of compression on water, and have determined the changes in film pressure which occur during the life of the drops. If the film is under a lower pressure than the spreading pressure, each drop penetrates the film and increases the film pressure. The larger the amount of benzene added, the larger becomes the increase in film pressure, until the latter equals the spreading pressure of the benzene, but no further increase in the amount of benzene will cause the film pressure to exceed the spreading pressure. Below a certain volume, drops of benzene evaporate before the film pressure equals the spreading pressure. If the film pressure is greater than the spreading pressure, the former decreases immediately benzene is added. The authors suggest explanations with reference to changes in shape and condition of the drops and also to solution of the film in the drops and its subsequent re-deposition.
R. D. S.

483. Oxygen Effect in the Reaction of Bromine with Neopentane *tert.*-Butylbenzene and Trimethylacetic Acid. M. S. Kharasch and M. Z. Fineman. *J. Amer. chem. Soc.*, 1941, **63**, 2776–2779.—Dilute solutions of bromine do not react with neopentane at room temperature even in the presence of oxygen, peroxides, or light, but at higher temperatures the reaction is stimulated by these agents; thus, at 50° C. organic peroxides accelerate the bromination to the same extent as oxygen at 80° C. Trimethylacetic acid is brominated slowly in the dark at 150° C., producing hydrogen bromide, carbon dioxide, mixed brominated hydrocarbons, and 9% of trimethylacetoxytrimethylacetic acid. Bromination of *tert.*-butylbenzene occurs in similar conditions to neopentane, and the reaction affects the nucleus and not the side-chain. This work confirms that primary hydrogen atoms are more difficult of bromination than secondary hydrogen atoms. R. D. S.

484. Oxidation Studies. II. Oxidation of Di*iso*butylene in the Presence of Potassium Hydroxide at Elevated Temperature and Pressure. R. W. Bost and L. B. Lockhard, Jr. *J. Amer. chem. Soc.*, 1941, **63**, 2790–2792.—Di*iso*butylene was oxidized by molecular oxygen in a bomb at 100° C. and 100 lb. per sq. in. pressure; the reaction was essentially complete after 8 hours. Acetone, 4 : 4-dimethylpentanone-2, carbon dioxide, formic acid, and pivalic acid were formed, together with unidentified oxygen-containing compounds boiling higher than any of the predicted products. R. D. S.

485. Action of Elementary Fluorine upon Organic Compounds. XI. Vapour-Phase Fluorination of Benzene. N. Fukuhara and L. A. Bigelow. *J. Amer. chem. Soc.*, 1941, **63**, 2792–2795.—Benzene was fluorinated in the apparatus recently described. The products isolated were CF_4, C_2F_6, C_3F_8, C_5F_{10}, C_5F_{10}, C_6F_{12}, C_6HF_{11}, and $C_{11}F_{22}$. The last four were believed to be decafluoro*cyclo*pentane, dodecafluoro*cyclo*hexane, undecafluoro*cyclo*hexane, and diundecafluoro*cyclo*hexyl, respectively. No aromatic fluorine compounds were isolated. The reaction is probably of the free radical type, and the initial attack of the halogen is presumably by direct addition to the ring.
R. D. S.

486. Influence and Behaviour of Thiophene in Aromatization Catalysts. R. W. Hummer and H. S. Taylor. *J. Amer. chem. Soc.*, 1941, **63**, 2801–2805.—The authors report the investigation of the effect of sulphur on two typical aromatization catalysts, chromium oxide and molybdenum oxide. These substances are active in removing sulphur compounds from gasoline and benzene. Thiophene was chosen since it is among the most difficult of such compounds to remove either catalytically or by liquid-phase treatments. It was found that the catalysts are highly efficient for the removal of thiophene at 470° C. Chromium oxide removes the thiophene in the form of hydrogen sulphide, but only traces of hydrogen sulphide appear with molybdenum oxide, from which most of the recovered sulphur comes out in the regenerative oxidation. Whereas thiophene poisons the aromatizing efficiency of chromium oxide to the extent of 60% decrease in yields, the activity of molybdenum oxide is enhanced : an increase in yield of 21–64% was produced by the presence of sulphur compounds in the molybdenum catalyst. R. D. S.

487. Raman Spectra of *cyclo*Pentane and Some of its Monoalkyl Derivatives. E. J. Rosenbaum and H. F. Jacobsen. *J. Amer. chem. Soc.*, 1941, **63**, 2841–2842.—Raman spectra are described for *cyclo*pentane and the following *cyclo*pentane derivatives : methyl, ethyl, *n*-propyl, *iso*propyl, *n*-butyl, *s*-butyl, *tert.*-butyl, *tert.*-amyl, and 3-*cyclo*pentylpentane. R. D. S.

488. Synthesis and Characterization of Some Tertiary Naphthenic Acids. B. Shive, W. W. Crouch, and H. L. Lochte. *J. Amer. chem. Soc.*, 1941, **63**, 2979–2984.—The chemical behaviour of the $C_{10}H_{18}O_2$ acid isolated from California and also, apparently, Iranian petroleum, limit the possible structures of this acid to the four which were accordingly synthesized. (1) *dl*-1 : 2 : 2-trimethyl*cyclo*hexanecarboxylic acid was prepared by the reduction of *dl*-camphorenic acid by hydrogenation in glacial acetic acid in the presence of Adams platinum catalyst ; (2) 1-*iso*propyl*cyclo*hexanecarboxylic acid was synthesised from *cyclo*hexanone via 2-carboethoxy-2-*iso*propyl*cyclo*hexanone and subsequent reduction of the carbonyl group by the Clemmensen method ; (3) 1-*iso*propyl-2-methyl*cyclo*pentanecarboxylic acid was synthesized via 2-carboethoxy-2-*iso*propyl*cyclo*pentanone from 2-carboethoxy*cyclo*pentane ; (4) αα-2-trimethyl*cyclo*pentane acetic acid was synthesized from 2-carboethoxy*cyclo*pentanone through 2-methyl*cyclo*pentanone. None of these acids was identical with the $C_{10}H_{18}O_2$ acid, but this work did result in the development of general methods for the syntheses of 1-alkyl*cyclo*alkanecarboxylic acid, and 1 : 2-dialkyl*cyclo*alkanecarboxylic acids by methods (2) and (3), respectively. R. D. S.

489.* Molecular Explanation of Retrograde Condensation. R. F. Nielsen. *Refiner*, February 1942, **21** (2), 40–42.—The phenomenon has been predicted from Van der Waals' theory for binary mixtures, and has been described and named in 1893. It is explained in this paper on the basis of attractive forces between the molecules. The case of ethane-heptane is studied in detail to illustrate the system.

The constants of Van der Waals' equation are studied and their significance as volume and attractive-force terms is detailed. The phenomenon of retrograde condensation is then explained qualitatively in terms of these attractive forces. A. H. N.

490. Patents on Chemistry and Physics. Standard Oil Co. E.P. 543,375, 23.2.42. Appl. 30.8.40. Continuous process for the endothermic catalytic conversion of hydrocarbons and the exothermic regeneration of the catalyst.

M.V. de Groote and B. Keiser. U.S.P. 2,273,181, 17.2.42. Appl. 7.7.41. Method of breaking petroleum emulsions of the water-in-oil type by subjecting to the action of a demulsifier comprising a compound of the following formula :—

$$D\overset{\cdot\cdot}{N}\!<\!\begin{matrix}\text{Halogen}\\ CH_2\text{–}CH_2\text{–}NH\cdot OC\cdot R\end{matrix}.$$

The acyl radicle R·CO is derived from a monocarboxy detergent-forming acid having at least 8 and not more than 32 carbon atoms. $D\overset{\cdot\cdot}{N}$ represents a radicle derived from a heterocyclic compound of the pyridine series. H. B. M.

Lubricants and Lubrication

491.* Changes Occurring in Oils and Engines from Use. F. A. Suess, H. C. Baldwin, W. A. Jones, and B. H. Lincoln. *Refiner*, February 1942, **21** (2), 51–62. *Paper presented before Society of Automobile Engineers.*—Some of the factors affecting the nature and degree of changes in engines or in the oil are physical and chemical, design and condition of the engine, conditions of service, such as speed, load, duration, ventilation, temperature, extraneous material from fuel, cooling system, combustion zone air, or other sources. Each of these factors and various combinations may affect different lubricating oil-engine systems differently.

Accordingly, the study and rating of oils and engines must include a study of many combinations of the more severe of all these factors. Reliable information cannot be obtained by one piece of laboratory equipment, or a single type of engine, or a single set of service conditions. To rate accurately lubricating oils or engines, a large number of tests on several pieces of equipment operated under a number of different sets of operating conditions is required. Each distinct test will produce a large number of types and degrees of change in both the oil and the test equipment, which must be isolated, evaluated, and recorded for comparison. Such a test programme faithfully carried out will produce a volume of data so large that conclusions and predictions are impossible without tabulating, correlating, and digesting all the data.

In outline, data are presented to show the changes which occurred in the lubricating oils and the engines during use in a comprehensive study which culminated in road tests. Prior to these road tests, a very extensive study was made of twelve commercial oils marketed as premium-grade oils by the predominant oil companies and fourteen experimental or development oils. If these twenty-six oils, three of the commercial oils and two of the experimental oils were found to display outstanding merit. These oils were therefore selected for extensive road tests, and the paper includes a discussion of the service changes in these oils and engines as follows: (1) Lubricants and equipment used. (2) Chemical laboratory and mechanical laboratory investigations. (3) Road tests. Each section is given in great detail. The mass of data accumulated and an analysis of the over-all picture of results certainly indicate that there is still considerable room for debate as to the optimum degree of peptizing or detergency desired in an oil. The minimum change in oil characterisitcs in service is most imperative, together with enough peptizing to prevent excessive deposition of materials of either intrinsic or extrinsic origin. The evidence certainly indicates the desirability of preventing the formation of products of oil change rather than permitting their formation and causing them to be dissolved in the oil, since such oil-soluble products result in accelerated rates of oil change due to their catalytic effect. A. H. N.

492. Patents on Lubricants and Lubrication. A. A. Schilling. U.S.P. 2,271,044, 27.1.42. Appl. 13.12.39. Preparation of a lubricant having metal surface corrosion-inhibiting properties. The mixture includes a mineral oil, a blend of 2 : 6-dimethylphenol and 2 : 4 : 6-trimethylphenol, and a mixture of mono- and di-lorol phosphates.

E. M. Dons ahd O. G. Mauro. U.S.P. 2,271,683, 3.2.42. Appl. 25.3.40. Admixture of a lubricating-oil stock with a solvent comprising 2-pentanone, 4-hydroxy-, 4-methyl, and diethyl glycol, and dissolving the naphthenic components of the stock oil in the solvent. The resultant solution is separated from the more paraffinic components of the lubricating-oil stock, and the solvent separated from the solution.

L. A. Hamilton and E. W. Fuller. U.S.P. 2,273,862, 24.2.42. Appl. 22.11.39. Preparation of a lubricating-oil composition consisting of a viscous mineral-oil fraction and a small proportion of an N-phenylphenylenediamine to prevent deterioration under oxidizing conditions.

J. S. Yule. U.S.P. 2,274,025, 24.2.42. Appl. 28.12.40. Manufacture of a lubricant consisting of a mineral lubricating oil and 0·1–5% of sulphurized and phosphorized fatty material.

L. H. Mulit. U.S.P. 2,274,302, 24.2.42. Appl. 22.1.40 Preparation of a lubricating composition consisting of a hydrocarbon oil, a small amount of a metal alcoholate to stabilize the oil against deterioration at high temperatures, and a salt of a sub-

stituted acid of phosphorus containing an organic substituent. The salt is added in sufficient quantity to minimize corrosive tendencies of the oil solution of metal alcoholate.

T. P. Remy. U.S.P. 2,274,305, 24.2.42. Appl. 6.5.38. Preparation of a lubricant consisting of a petroleum lubricating oil and a small amount of chlorinated *iso*prene containing more than 50% chlorine.

T. P. Remy. U.S.P. 2,274,617, 24.2.42. Appl. 27.4.38. Preparation of a lubricant consisting of a petroleum lubricant and about 3% of a sterol to increase oil-film strength and prevent sludging. H. B. M.

Special Products.

493. Patents on Special Products. Standard Oil Development Co. E.P. 542,925, 3.2.42. Appl. 23.4.40.—Improvements in processes relating to the subjection of materials consisting essentially of hydrocarbons boiling in the gasoline range to heat treatment at a temperature above 500° F., and in the presence of catalysts to produce a dehydrogenated or otherwise chemically reconstructed product.

Standard Oil Development Co. E.P. 542,995, 5.2.42. Appl. 27.6.40. An improved method of converting normal paraffins into *iso*paraffins by subjecting the normal hydrocarbon to the action of a Friedel-Crafts metal halide catalyst modified with an alkali metal halide while at a temperature below 400° F. It is claimed that the process may be used to increase the anti-detonation value of normal naphthas. Normal butane and normal pentane may be converted into the *iso*-compounds, which are more reactive for alkylation with olefins.

Holford Processes, Ltd. E.P. 542,996, 5.2.42. Appl. Appl. 29.6.40. Process for the simultaneous production or purification of oil, together with the production of a hard, carbonaceous residue. An oil, or a blend of oils, is mixed with peat or similar solid carbonaceous substance containing volatile matter, and the whole subjected to distillation.

A. J. Van Peski. U.S.P. 2,271,043, 27.1.42. Appl. 5.9.39. Process for the isomerization of a saturated aliphatic hydrocarbon containing between three and six carbon atoms with an aluminium halide catalyst. The isomerization is effected under 0·08–33 atmospheres pressure of hydrogen, the partial pressure of the hydrogen being sufficient substantially to repress undesirable side reactions, but insufficient substantially to repress the isomerization reaction.

P. K. Frolich. U.S.P. 2,271,636, 3.2.42. Appl. 6.6.33. Preparation of high-molecular-weight polymerization products having the properties of plastic solids rather than of viscous lubricating oils, soluble in hydrocarbon oils, and capable of improving the viscosity–temperature characteristics of lubricating oils when blended therewith.

W. H. James and E. W. Fuller. U.S.P. 2,271,940, 3.2.42. Appl. 2.3.40. Production of a high-boiling petroleum product stabilized against formation of acidic and sludge products of oxidation by the addition thereto of a small amount of the oil-soluble condensation reaction product formed by reacting a tri-nitrated member of the group consisting of benzene, toluene, cresol, resorcinal, anisole, with a member of the group consisting of naphthylamine and substituted naphthylamines.

V. N. Ipatieff and A. V. Grosse. U.S.P. 2,273,320, 17.2.42. Appl. 23.3.39. Production of a higher-molecular-weight mono-olefin hydrocarbon from a lower-molecular-weight olefin hydrocarbon and a *cyclo*paraffin. An olefin is reacted with a *cyclo*paraffin of less than five carbon atoms in the ring in the presence of a condensation catalyst under conditions of pressure and temperature effective for the condensation reactions. H. B. M.

Coal and Shale.

494.* Liquid Pitch Fuel. E. B. Davies. *J. Inst. Fuel*, 1941, **15**, 80, 15.—Contrary to former expectations, recent developments in the technique of using pitch as fuel have been along the lines of using the material in liquid rather than pulverized form.

Physical data on normal medium soft pitch, relevant to its use in molten form, are given as follows: Softening pt. (K. and S.), 70° C.; cal. val., 16,250 B.Th.U./lb.; sp. ht. 0·4; latent ht. fusion, negligible. Typical curves showing viscosity *vs.* temp. and sp. gr. *vs.* temp. are given.

Whilst transport of molten pitch in insulated wagons is feasible, it is safer to arrange the consuming plant to operate mainly on liquid deliveries, but to include also melting facilities for make-up and emergencies.

The following equipment is described and discussed in some detail: steam coil, hot oil, and electrically heated melters; storage and feed systems for liquid pitch; valves and cocks; pumps; burners.

The paper is illustrated with numerous graphs and diagrams. C. G. G.

Economics and Statistics

495. Survey of Fuel Consumption at Refineries in 1940. G. R. Hopkins. *U.S. Bur. Mines. Report of Investigations*, No. 3607, January 1942.—The almost invariable rule that the average amount of heat required to refine a barrel of crude oil declines as crude runs to stills increase was broken in the United States in 1940. In fact, the average heat requirement per barrel of crude oil rose from 55,000 B.t.u. in 1939 to 579,000 B.t.u. in 1940, although crude runs increased from 1,237,840,000 brls. to 1,294,162,000 in that period. According to this report, no very definite reason can be given for this apparent loss in fuel efficiency. The principle of heat exchange was used as extensively in 1940 as in the previous year; also the yield of complex products, known to require more fuel in production, actually declined in 1940.

There were, however, several developments in 1940 which tended to increase fuel requirements, notably the greater output of aviation gasoline and the tendency for refiners to expand operations in thermal reforming, gas reversion, or other light-end processing, as a means of maintaining gasoline quality.

Consumption of fuel oil in refineries remained about the same in 1940 as in 1939, a total of 32,085,000 brls. being recorded for the year under review. This represented 25·7% of total heat units consumed in refineries in 1940.

Acid sludge became more economically attractive during the year, and total heat units supplied increased from 2·6% in 1939 to 2·7% in 1940. In spite of advancing prices, refiners increased their consumption of coal by 32% during 1940, and this fuel was responsible for 3·4% of total heat units.

Total consumption of natural gas rose to 128,007,000,000 cu. ft. in 1940, or 31% above the 1939 level, and increased use of this fuel at refineries was quite the most outstanding change recorded in character of fuel employed.

The remainder of total heat units were supplied by still gas (50·7%), petroleum coke (less than 1%), steam, and purchased electricity. H. B. M.

BOOK REVIEW.

Stratigraphic Type Oil-Fields [U.S.A.]. Edited by A. I. Levorsen. 902 pp. Bibliography including Canada, Trinidad, and Venezuela. American Association of Petroleum Geologists, Tulsa, Oklahoma. $5.50.

This important book reflects the increasing amount of work being done by petroleum geologists on stratigraphy, on conditions of sedimentation, and on questions relating to the porosities and microscopic composition of rocks as determining oil occurrence. A stratigraphical reservoir is one closed by varying permeability either of the oil-rock or of adjacent strata; and the term may be extended to include those fields where closure by tilting, folding, or faulting is subsidiary to the lithological factor. The volume deals with thirty-seven such examples, and many other stratigraphical fields are succinctly referred to in the annotated bibliography. This new symposium forms an invaluable supplement to that in two volumes on *Structure of Typical American Oil-Fields*, published by the A.A.P.G. in 1929, in which the emphasis lay on the tectonic side. Salt Creek, Wyoming, is an example where the oil-trap is bounded on all sides by structural anomaly, whereas in shoestring pools—ten of these which originated as sandspits are described in the work under review—oil accumulation is almost entirely a function of sand distribution, with local structure playing a minimal part in localizing the oil. Other stratigraphical pools are found where porosity wedges against coast-lines or areas of uplift are overlapped by impervious strata, as in several East Texan fields; or where there is lateral change of permeability due to solution cavities, as in limestone reservoirs of New Mexico and West Texas, or due to dolomitization as in the Trenton (Ordovician) limestone of Ohio and Indiana; or where there are changes due to original deposition, as in the flood-plain and delta deposits of Montana and Alberta. Differential cementation and clogging by viscous bitumens are also important. Most of the "synclinal" fields of the Appalachian province are probably the result of depositional and porosity variations, although, as in the Berea sand (basal Mississippian) of the Gay-Spencer-Richardson trend of West Virginia, structure may also be of significance. Pools where porous igneous rocks—for example, the serpentines or serpentine sediments of Central Texas—form the reservoir are likewise to be treated as stratigraphical.

California.—In the Edison field, sands deposited off an original promontory were sealed in by transgressing shales. Miocene warping produced a north-west pitch. Oil is yielded from the Walker sand and ash (?Eocene–Miocene), the Jewett silt, and the Olcese sand (Lower Miocene). Upper Duff oil, in the base of the fan alluvials of the Kern River formation (Pliocene–Pleistocene), is bounded on the south by change of porosity and in the north-east against a fault which moved in Kern River time. In the Kern Front field, three oil-sands, imbricately arranged, occur in the Chanac formation (?Upper Miocene), which is alluvial, but has more soil content than the Kern River. The structure is a south-west dipping monocline without closure. Faults have a sealing of gouge derived from weathered minerals, but their throws are less than the thickness of the oil zones. The Chanac has less than 10% sand in the north-west, but coarsens down dip. Most of the oil is located where there is 10–30% of sand.

Colorado.—The Greasewood field is on a very gentle anticline dipping about 7 ft./ml. on the south-west and up to 20 ft./ml. on the north-east. Oil is found in the Greasewood sand (Upper Cretaceous), the top member of the Dakota group. The sand has poor porosity, maximum 9%, and in places is rendered quartzitic by deposition of secondary quartz. It thins and thickens by lensing. Westward divergence of the top and bottom of the Upper Cretaceous points to subsidence during deposition. Dip in the Greasewood is greater than in surface beds. It wedges out down dip, while to the north-east the Niles fault acts as a barrier. Accumulation is thus due to mixed structural and stratigraphical factors. Bottom temperatures are high, and the oil is gas-propelled so that successive wells reduce production from those already in operation.

Kansas.—A sand-stringer, high in the Cherokee shale (Lower Pennsylvanian), 13 mls. long by 1000–2000 ft. wide, and 0–50 ft. thick, is the source of oil in the Bush City field. It is convex on the underside and flattened on top, with some irregularities possibly due to late stream action. It fills a channel carved in shale, and the wider parts are shallower than the others. The lower measures of fine, micaceous, slightly sub-rounded sand, forms the pay-zone. Warping of shales over the sand is attributed to differential compaction, and flattening out of the channel sides may also be due to this. Seven anticlinal flexures are crossed by the sand-body, on the crests of which initial production has invariably been highest in oil and gas, while in the synclines there is little gas. As the sand is dry, it is suggested that water was replaced by oil first on the anticlines and later, when less oil was available, in the synclines.

In the Chanute oil-pool, now revived by water-flooding, a deposit of fine, well-sorted, sometimes cross-bedded sand, in the Cherokee, forms a shoestring several times longer than wide. It has a flat base, and is convex upwards, but slopes more steeply on the east side. The outline is a smooth curve on the east, but the western margin is irregular. These features suggest that the sand collected, like the Bartlesville and Burbank shoestrings, as an off-shore bar. A coal-seam under part of the sand shows how the waves of the Pennsylvanian sea drove the sand landward over a fresh-water swamp. Significantly enough, the sand-body is more permeable to water longitudinally, the better-consolidated layers lying at right angles to the direction of fetch of the storm-waves that built the bar. For further details of interpretation the attention of the authors may be directed to recent work on comparable present-day sand accumulations by European authors, including W. V. Lewis (*Proc. Geol. Assoc.*, xlix, 1938, 107–127), A. Lamont (*Scot. Geogr. Mag.*, lv, 1939, 317–331), M. A. Arber (*Nature*, cxlvi, 1940, 27–28), R. A. Bagnold (*Journ. Inst. C.E.*, xv, 1940, 27–52), and I. N. Lobanov (*Nature, Acad. Sci. U.S.S.R.*, i, 1940, 77–79). For flooding, water from the Neosho river is mixed with water from the oil-wells, and is treated with lime and alum; chlorine and copper sulphate are added to kill algæ which would otherwise clog the filters of the water-treatment plant and pore-spaces of the oil-sand. Clear water is pumped into the input wells.

The Hugoton gas-field yields from drusy dolomite in the Sumner group and from dolomite passing down into bryozoan and fusulinid limestone of the Chase group, both in the "Big Blue" lower division of the Permian. The dolomitization is secondary, and weathering is evident from the presence of soft, white, porous cherts. That gas is specially rich in a zone of almost pure dolomite indicates the importance of shrinkage during dolomitization in creating porosity. Apart from slight interruption by westward-pitching noses of broad anticlines, the beds dip to the east. To west, porosity is lost, since micaceous silts and red shales of terrigenous character, from a Permian land-mass of the southern Rocky Mountains, replace the marine limestones. Initial pressures at about 436 lb./sq. in. are sub-normal, and suggest communication with the Amarillo gas-field, where initial pressures approximate to 430 lb. The water-table seems to show some adjustment, since the conclusion of eastward tilting of the beds.

The Nikkel pool, on the Voshell anticlinal trend, is remarkable, since a folded and faulted outlier of Hunton dolomite and glauconitic limestone (Siluro-Devonian) has been sealed between Maquoketa shale (Ordovician) with graptolites below and strongly unconformable Kinderhook shale (Lower Carboniferous) above. At the Wherry Pool, production is described from levels in the Sooy conglomerate, which varies in thickness, and consists of chert pebbles deposited in shallow marine waters at the time of the Mississippian–Pennsylvanian unconformity. The regional dip is steadily south-east off the margin of the Central Kansas uplift. In Zenith pool, Misiner sand (basal Mississippian) is in contact with Maquoketa vuggy magnesian-limestone and shale with conodonts, underlain by Viola limestone and cherty dolomite (Ordovician), the last forming the chief reservoir. A nose structure extends south over the pool, but there is no closure to north or west, so that oil concentration must be accounted for by lateral changes of permeability, by truncation of the oil formations in the north, and by a Kinderhook seal.

Kentucky.—The Big Sinking field lies on the south-eastward dipping side of the Cincinnati arch, and the yield is from Lockport cherty limestone (Silurian), now a sucrose dolomite, from which calcite fossils were dissolved probably in the late

Devonian, leaving cavities lined with dolomite crystals. The Lockport thins westward, and is replaced at outcrop by Hamilton limestone (Middle Devonian). Seals are the underlying Clinton red and green shales (Silurian) and Devonian and Carboniferous black shales. Local closures may be due to the irregular topography of the weathered Lockport surface, but the general configuration seems to depend upon a buried and eroded, or even completely planed down, structural "high."

Louisiana.—In East Baton Rouge parish, seven Miocene sands on a domal structure are producers or potential producers. Concentration in three cases is controlled by pinch-out, or by pinch-out and entrance of a shale-wedge, as well as by structure. For the Miocene of the Gulf Coast erratic contemporaneous deposition from several sources has been assumed. Electrical logs are a great help in plotting lateral changes.

Michigan.—In the gas-fields of southern Michigan shoestring developments of the Stray sand (Mississippian) are interpreted as sandspits resting unconformably on shoals of Upper Marshall sandstone. The latter is a very clean Carboniferous sand which, to the authors, suggests deposition during a dry epoch. The fields of Austin and Six Lakes, lying on the same north-west trend, are described in detail, and the shore parallel to which they have formed is attributed ultimately to anticlinal folding. One is inclined to enquire whether the pre-Stray ridges may have been preferentially preserved under the sand-bars. Again, in the Austin field, is it possible that the larger and smaller accumulations flanked the sides of a river-mouth, with drift of sand alongshore from the north-west? The thickest and highest accumulations are least muddy, most porous, and give the biggest yields, so that the features of the bars can be shown by means of isopore and production maps. Cross-sections suggest longest fetch of waves from the south-west, but there are difficulties about the palæogeographical distribution of land. The authors are to be congratulated on their detailed maps, made from bore records in country covered by glacial drift, but a large-scale outline of all the twenty-three spits might throw additional light on direction of beach-drift and relative ages of bars.

Montana and Alberta.—The Border-Red Coulee oilfield derives its yield from the Cosmos quartz and chert sands, at the base of the continental Lower Cretaceous. They lie unconformably on the Ellis formation (Jurassic), from the shale and limestone of which all the oil may be derived. There are lenticular and other stratigraphical traps. Migration has taken place through joints, and a buried hill of Madison limestone (Lower Mississippian) has localized the production.

Montana.—Oil and gas in Cut Bank field, in monoclinal beds on the west side of the Sweet Grass arch, are obtained from similar black chert-sands of the Kootenai (Lower Cretaceous), which were derived from erosion of a Jurassic upland in the position of the Selkirk and Purcell ranges, 160–300 mls. west and north-west of the field. The trap is due to irregular sedimentation in a flood-plain and delta environment, and may represent spit or beach deposits on the margin of a large body of fresh(?) water. Cementation prevents edge-water from encroaching. Tilting is indicated by variation of water-level from 1300 ft. above sea-level in the north-east to 600 ft. above sea-level, down dip, in the west.

Ohio.—In eastern Ohio lensing sands are important in formations from the Clinton (Silurian) to the Cow Run (Pennsylvanian), but about 65% of production, including that from the Berea sand at the base of the Mississippian, has some structural factor. Following flooding operations, the Berea is soon likely to take precedence of the Clinton.

Oklahoma.—The Davenport field, Lincoln County, produces from the Cleveland and Prue sands (Pennsylvanian). In a gently westward dipping monocline the Prue sand pinches out in all directions. The Dora pool, Seminole County, is also in an irregular lenticle, slightly convex upwards, probably formed as a beach deposit of Pennsylvanian age. The general dip is to south-east. In the East Tuskegee pool, Creek County, production is from the Misiner fine marine sand with some chert conglomerate and dolomite (basal Mississippian), probably laid down near shore, and from the Wilcox (Ordovician). Wilcox production is restricted to structural apices, but the laterally inconstant Misiner yields from the flanks of "highs." The Olympic pool, Hughes and Okfuskee Counties, with flat bottom and convex top, running 6½ mls. from north to south and ½–1½ mls. wide, is in the Senora formation, well down in the Pennsylvanian. It pinches out steeply on the east side,

more gradually to the west. An original eastward slope of the sea-floor can be demonstrated, and the history is almost certainly of a spit that grew southwards, with almost equal exposure throughout its length to maximum constructive waves fetching from a little south of east. In the southern lobe over 70 ft. of sand has accumulated. A north–south channel in the northern part may be tidal or due to break-through by a river.

The Red Fork shoestring (Pennsylvanian), in North-Eastern Oklahoma, is of the same age as the Burbank, and represents two sandspits growing from opposite sides of an estuary. That beach-drift was predominantly from the present north seems likely in view of the larger number of wells in the spit on that side. Most interesting is the "Basin Red Fork," a silt bank, at the river-mouth. Outflow probably went on for some time after the turn of the tide because of water ponded in the spit-protected lagoons, and the reviewer would point to the analogy of the former "Dogger" bank opposite the Slaney estuary, in Ireland. The Red Fork sediments are fine in comparison with the material of modern beaches. This is taken as illustrating quiet marine conditions. The relative scarcity of coarse sediment cannot be due to poor rainfall, since there are coal-seams of equal age, so that a planated topography must be invoked, upon which the Cherokee sea gradually stepped westward.

Pennsylvania.—An Upper Devonian sandspit, 4 mls. long and 800–2000 ft. wide, is formed by the Sliverville sand of sub-angular medium to coarse grains, in the Music Mountain oil-pool, McKean County. The spit thickens towards the south, but its level rises north-eastwards as it lies obliquely on the side of the Bradford anticline which plunges to the south-west. Connate water has not been reported; gas expansion expels the oil.

The Venango sands of the Catskill (Upper Devonian) and basal Pocono (Mississippian) are discontinuous sands which may be grouped in three successive types: (1) small sands at right angles to the ancient shore-line, possibly filling distributary channels, with fine material landward becoming coarse towards the sea; (2) sheet-sands which pinch out along smooth edges of a stratigraphical nature on their north-west sides parallel with the shore, and which are generally fine-grained and red towards the land; (3) long, narrow, north-easterly trending, pebbly bars, with some discoidal pebbles. Cementation is good with growth of secondary quartz, but in the coarsest beds absence of cementation may be due to early entry of oil.

Texas.—The Bryson field is interesting because oil occurs in a north-dipping monocline that formerly dipped south, and since several members of the Bryson sand-zone, in the Strawn (Pennsylvanian), lose permeability at the same linear position up dip. In Brown County the Cross Cut sand, Canyon (Pennsylvanian), has sand-lenses which are thickest on the higher parts of the pre-Cross Cut topography where they would be least affected by stream erosion. The area of accumulation is on or near the Bend flexure. Oil usually occupies the tops of the lenses, either above the thickest parts, or where anticlinal noses cross the flexure.

The Davis sand-bar, Hardin field, Liberty County, is of medium, clean, angular to sub-angular quartz grains, with few heavy minerals. On its inshore side, or near the mouth of a stream, it contains leaves of *Sapindus* cf. *georgiana* Berry. The length of the spit is over 2 mls., average width 125 ft., height 45 ft. Its deposition may have been begun at 5 or 6 mls. from the land, but it was deserted by the retreating Middle Yegua sea (Upper Eocene) and at the same time the landward lagoon was filled by fine sand. Its steeper side faces the land. Preservation was effected by ample precipitation of calcareous matrix. The pool appears to be sealed in all round.

The East Texas field lies on a westward-dipping homocline at a position where the Eagle Ford and Woodbine sands are bevelled up dip by transgression of the Austin Chalk. The finer strata are mainly non-marine, and comprise red, green, and black shales, poor in lime and laterally inconstant. The sands are variable, with many disconformities, stream channels, much cross-bedding and irregular lamination. Water which allowed siliceous cementation was only replaced by oil where the sands were poor in fine material. Silty sand with up to 17·5% porosity may thus be without oil. Some of the fine mud seems to be an altered ash. Water is now encroaching from the west where bottom-hole pressures are highest.

The Hitchcock field, in Galveston County, yields from Middle Miocene sand which

on three sides dips off a flat dome, but on the east lenses out. The gas-cap is small, and the gas/oil ratio large. Miocene beds above the producing sand have been erratically deposited: numerous faults were erroneously postulated in the first interpretation of the electrical logs.

In the Hull-Silk field, Archer County, an east-south-east–west-north-west anticline has a closure of 90 ft. on the Caddo lime, Bend (basal Pennsylvanian), but, higher up, closure is less marked in four oil-sands of the Strawn (Pennsylvanian), in which lack of porosity limits the occurrence of oil. In the 4300-ft. sand rather more than half the production is from positions below the closure. Effective closure was formerly greater, but has been reduced by eastward tilting.

The Lopez field, about 16 mls. north of Bruni, produces from the Lopez or West Cole sand at the top of the Mirando (Eocene). The structure is a terraced to faintly synclinal monocline, with sand thinning out up dip and occupying a long embayment in the strand line. There is no surface indication of the field apart from its lying on the same trend as the West Cole and French fields and a slight flattening of dip. The Noodle Creek field, north-west of Abilene, is also on a terrace, with a number of areas of closure. Absence of porosity in the Noodle Creek limestone, Cisco (Pennsylvanian), on the east side, has retarded movement of fluid. Minor accumulations far down on structural flanks are evidence of channels of permeability leading from the major pool.

In a downthrown block on the south-east limb of the Cole–Bruni anticline, oil is yielded from the O'Hern sand (Eocene) at or near the contact of the Jackson and the Cockfield–Yegua formations. It is a shore-line sand-wedge, forming an inland-pointing tongue which grades into impervious shaly beds towards land and thickens seaward and south-eastward to a maximum of 30 ft. An area where the sand is of minimal thickness occurs along the centre of the tongue, and gives sub-normal production. Non-marine appearances and brackish Foraminifera hint that this area may be the end of a river-course blocked towards the sea by wave-sorted material (pp. 726–727). The channel was possibly filled in by muddy and wet silty sludge before the completion of O'Hern deposition, since the contours of the upper surface show a later hollow, perhaps of another channel, south of the principal minimum, and again this ends with a pit and a blocked mouth (p. 734). In a marginal zone all wells have had to be pumped from the start. Gas-wells are widely distributed in structural position, but are all in the pumping zone. The gas may come out of oil held captive by capillarity and adhesion to sand. Pore-space becomes less towards the fringes of the deposit.

In the Sand Belt field which runs roughly north–south, several miles east of the Capitan reef front, structure in surficial beds of Tertiary and Recent age is poor, but beneath the Trias, at least in the north, there is an anticlinal. Production is mostly from below the top of the Yates (Permian), and depends on the varying porosity of beds of sand and dolomitic sand.

The Seymour pool, Baylor County, yields from a reservoir of grey, soft, crystalline limestone with fossils, deposited as a reef in the Canyon series (Pennsylvanian). Structure at ground level in red and yellow Permian shales betrays no evidence of the reef. The latter was built, after crustal warping of Middle Canyon date, on a westward tilted floor of Palo Pinto limestone with chert bands. The upper surface of the reef has a more gentle slope to the west than to the east.

In the Walnut Bend pool, Cooke County, anticlinal structure is responsible for oil in the Simpson dolomite (Ordovician), and in the 4900-ft. and 5100-ft. sands of the Lower Red Strawn (Pennsylvanian), but in the 4100-ft., 4600-ft., and 4700-ft. zones, as shown by cross-sections based on electrical logs, stratigraphical traps are determined by gradation of sandstone into shale. Skiagraphic structural maps explain clearly the simple, steep-sided, north-west–south-east elongate dome of the Simpson, as contrasted with the overlying Pennsylvanian structure in which a number of radiating folds pitch off a much gentler dome. In successively higher beds amounts of dip are diminished.

West Virginia.—The Berea sand, at the base of the Mississippian, running from west-south-west to east-north-east in parts of Jackson, Roane, and Calhoun Counties, is bounded above by black shales which are pyritized at the contact, as a result, it is suggested, of a reaction connected with oil formation, and is sealed underneath by light grey, silty shale of variable thickness at the top of the Devonian. The

sinuous form of both sides of this body of fine, quartz sand militates somewhat against its being a sand-bar. Nevertheless, the upper surface shows longitudinal ridges with a steep slope to the seaward side. After suggesting that, in an area of low relief, the coastal outline may have been affected by earth-movements which initiated the first slight anticlines that were later so strongly folded, Heck ascribes to this factor the changing course of his off-shore bar. The L-shaped bend of the sand, where intensively developed in the Richardson field, is not readily explicable on a simple sand-bar hypothesis, or even if we presume that we are dealing with a shore sand, unless there was a small island of Devonian shale south of Richardson. This would be helpful, since sand drifting from the north-east might have extended towards it in a short tombolo, and at the same time it would have served to protect the anomalous north-west–south-east accumulation of sand from being dissipated by waves from east and east-south-east. The oblique incidence of these no doubt promoted the general beach-drift from the north-east. Farther south the possibility of a sand-bar passing into a storm-beach may be borne in mind. The well-known absence of water in the Berea sand may be due, as Thom says, to absorption of water by neighbouring clays, when unloading following partial erosion of superincumbent beds permitted increase in the size of spaces between the clay particles.

The Shinnston pool, Harrison County, is segregated in a sand of Upper Devonian age, depleted of water, and lying in a westerly dipping homocline. The oil would have descended westward into the Shinnston syncline but for the tightness of the western sand.

Wyoming.—The Osage field, Weston County, lies on a terraced homocline that dips west from the Black Hills uplift. Much of the oil is in Newcastle muddy sandstone, which in places contains lignite and which is of mixed marine, brackish, and continental origin. The Newcastle is enclosed as lenticles in the predominantly marine shales of the Graneros formation which constitutes the basal division of the Upper Cretaceous. Tilting and flexuring were of Laramide date.

Space fails in which to pay tribute to the work of the editor and of the individual authors who have made the production of this splendid volume possible. The material presented and the manner in which it has been presented will be an education and inspiration for all students of petroleum production for many years to come.

ARCHIE LAMONT.

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Geology and Development.

496.* Some Silurian Correlations in Lower Mississippi Drainage Basin. J. R. Ball. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, **26** (1), 1–18.—The Niagaran (Middle Silurian) of Tennessee begins with the grey and red shaly Osgood limestone, 17 ft., of Clinton age, with crinoid roots, ostracods, and some orthoceratites of small diameter. The succeeding, well-bedded, greyish-pink or flesh-coloured Laurel limestone, 30 ft., forming the base of the Lockport, contains scattered calcite rhombs of deeper hue and clusters of crinoid roots and ossicles. The Waldron grey and green shales, 0–5 ft., have a considerable fauna, but above them the bluish-grey Lego limestone, 45 ft., is poor in fossils. The Dixon red shale and mottled limestone, 45 ft., near the top, has a thin but persistent horizon with large *Dalmanites*, and fistuliporoids are more

widely disseminated. At the top of the Niagaran, the Brownsport formation, 250 ft., comprises bluish-grey argillaceous layers and crystalline limestones, often grey or purple, with crinoids and some flattened nodules of black chert, and is notably fossiliferous.

The Bainbridge, 30–150 ft., of Missouri, includes the whole Niagaran. At Greither Hill, *Pisocrinus* shales of the Brownsport rest on either Laurel or Dixon, and there is a greenish-grey *Merista* bed corresponding with part of the Bob limestone, Middle Brownsport.

Only the bottom part, 40–50 ft., of the sequence is present in Illinois.

In Arkansas the grey to pink crinoidal St. Clair limestone, 0–100 ft., and the Lafferty red-mottled limestone, 0–85 ft., represent the whole Niagaran.

Under these beds in each of the four States lies the Brassfield limestone, 0–70 ft., often glauconitic and cherty, which forms the top of the Alexandrian Series (Lower Silurian). A. L.

497.* Geochemistry of Natural Gas in Appalachian Province. P. H. Price and A. J. W. Headlee. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, **26** (1), 19–35.—Investigation of the simpler hydrocarbons in natural gas is one geochemical method in the search for oil. The total heating value of a natural gas on an inert free basis depends on the proportions of hydrocarbons present, so that iso-Thv maps give a valuable indication of lateral changes of composition. In the Appalachian–Ontario area total heating value is highest—1250 to over 1450 B.T.U.—in a belt running from Charleston, West Virginia, passing west of Pittsburgh, and expanding in the north to include Cleveland, Ohio, and the south-eastern part of Lake Erie, beneath which both oil and gas may be present. Towards the eastern margin of the area gases decrease in Thv and approach pure methane, so that they have a low-carbon high-volatile composition where high-carbon low-volatile coals occur. Traced west from the axis of the Pittsburgh–Huntington basin, the carbon percentage in the coals steadily falls, and the same thing happens in the gases. It is clear that changes in natural gas conform with position in the basin, and not with degree of dynamic metamorphism, as in the case of coals. Towards the centre of the Michigan Basin Thv also rises.

In the Oriskany (Lower Devonian) of the Elk–Poca field, commercial oil may be found above the 1180 isometric Thv line—*e.g.*, in the north-east where there is also a low nitrogen percentage and where the quantity of hexanes and higher-boiling hydrocarbons decreases. The Oriskany itself has less than 0·02% carbon dioxide, but strata below it show up to 45%, possibly owing to former bacterial action under stagnant conditions. Hydrogen sulphide, absent above the Oriskany, increases to 25% beneath it, and is attributed to bacteria acting on sulphates and sulphur-containing proteins probably on the deep floor of a quiet sea.

Similar data are given for the Villa Nova field, opened in 1940, which yields from the Webster Springs and Big Lime (Mississippian) formations, and a graph shows increase of heating value and likelihood of oil occurrence corresponding with decrease of methane. A quantitative relationship may also exist between frequency of different hydrocarbons in gas and the amount of oil associated with it in a reservoir.

Gas from very near coal-seams tends to be rich in methane, since coal absorbs the higher hydrocarbons; and if gas migrates to the surface through coal-seams, it loses the constituents which indicate oil possibilities. Near-surface gases have no ethane, propane, butane, pentane, etc., but much methane, and usually relatively high nitrogen. In course of time, reduced organic matter reacts with methane to give equilibrium mixtures of hydrocarbons. A. L.

498.* Criteria for Subsurface Recognition of Unconformities. W. C. Krumbein. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, **26** (1), 36–62.—The term *unconformity* includes (1) *non-conformity*, involving folding and erosion of the older strata, and (2) *disconformity*, due to erosion or non-deposition. *Diastem* is a minor gap of rank lower than a formation; and *ravinement* describes a disconformity produced by movement of masses of water. Unconformities may be associated with wind, stream, glacial, deltaic, beach, or marine deposits. A single unconformity may occur at more than one level in a stratigraphical column. A number of diastems may branch out from a principal unconformity.

The sedimentary, palaeontological, and structural criteria of unconformities may be

tabulated as follows (those that are less reliable and need confirmation from other lines of evidence are indicated by an asterisk) :—

A. SEDIMENTARY.—(1) Basal conglomerate with residual or weathered pebbles of underlying formation, often thinning or becoming more finely grained to seaward; (2)* basal black shale where a transgressive sea has flooded a land surface with richly organic soil; (3)* desert varnish of iron and manganese oxides on pebbles; (4) lag gravels from which wind or water currents have removed fine material, and deposits with aeolian bedding or dreikanter; (5)* edgewise conglomerates usually marking diastems due to local erosion, shoaling, seismic sea-waves; (6) weathered cherts and silicified or flint-bearing layers at or below erosion surfaces; (7)* richly glauconitic layers; (8)* phosphatic nodules and phosphatized surfaces; (9) numerous nodules of iron-manganese carbonate; (10)* iron-oxide zones which may form under erosion surfaces; (11)* pyritiferous zones; (12)* caliche deposits of soluble salts and duricrust; (13)* corrosion surfaces on pebbles; (14)* interbedded conglomerates; (15)* abrupt appearance of clastic beds, like sandstones, in non-clastic sequences; (16) sudden changes in heavy-mineral assemblages which are often much richer above an unconformity than below it; (17)* beds with concentrations of radioactive minerals; (18)* porous zones in limestone, etc; (19)* sharp differences in lithology, especially abrupt change from marine to continental strata and change in chemical constitution; (20)* asphaltic residues or oil-staining; (21)* X-ray patterns from powdered cuttings which indicate presence of phosphate, glauconite, etc.; (22)* concretions and pisolites; (23) buried soil profiles—*e.g.*, humus layers in the Pleistocene, and lateritic beds in older formations.

B. PALAEONTOLOGICAL.—(1) Sudden changes of fauna and omission of expected faunas; (2) gaps in the line of development of fossil species that show mutation in an orderly direction; (3) borings by littoral organisms; ¶(4)* hiatuses which yield land-plants or animals in place; (5)* calcium-carbonate biscuits deposited by algae; (6) lateral spreading of coral-reefs which would be built steadily upwards if sedimentation were continuous; (7) bone and tooth conglomerates that show signs of having been re-worked; (8) beekite rings—*i.e.*, droplets of opaque to translucent quartz due to silicification of shelly fossils under surfaces of uplift or erosion.

C. STRUCTURAL.—(1) Discordance of dip; (2) undulatory surface of contact; (3) truncation of dykes, etc.; (4) larger number and greater throw of some faults in older of two superimposed formations.

Where two or more of the criteria are fulfilled, the possibility of unconformable relations is enhanced. In the future help may be obtained from increasing knowledge of soil-forming processes in terms of profiles that develop from given rock types under different climatic conditions, and from information about phenomena associated with submarine non-deposition. The lateral extension of known unconformities by judicious use of the less certain criteria is as important as the finding of new unconformities. A. L.

499.* Basal Beds of Salado Formation in Fletcher Potash Core Test, Near Carlsbad, New Mexico. W. B. Lang. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, **26** (1). 63–79.—East of Carlsbad, New Mexico, under 890 ft. of beds comprising Quaternary caliche, Triassic red beds of which the Pierce Canyon member reaches the exceptional thickness of 505 ft., and Rustler (Permian), 320 ft., lies the Salt or Salado formation (Permian), 490 ft., of mainly chemical sediments. The Salado is thinned by bevelling towards the south-west, so that in the core the sylvite-bearing upper section is missing. Knowledge of the position and exact character of anhydrite, polyhalite, and shale beds allows of stratigraphical correlation within the Salado, in which three distinctive members are the Cowden anhydrite, 18½ ft., the La Huerta siltstone, 15 ft., and the Fletcher anhydrite, 69 ft. The last rests after erosional unconformity on the Carlsbad reef limestone, normally less than 10 ml. wide, but surrounding the Delaware Basin, which is 100 ml. in diameter, like a distorted ring.

The Cowden begins with 2-in. grey magnesitic shale forming the base of 2 ft. of fine, dense anhydrite. This grades up into 1½ ft. shaly magnesitic anhydrite, followed by 2 ft. of glassy anhydrite with seams of white magnesite crumpled and disrupted by anhydrite pseudomorphs after gypsum crystals that grew from the upper surfaces of the seams. The upper 13 ft. are of massive graphic anhydrite with brown ferruginous blotches contributing to the marmoreal appearance. Secondary acicular

crystals of anhydrite are associated with whitish magnesite, and fractures are cemented with halite. At the very top there is gradation from banded anhydrite into less than 1 ft. of coarsely granular halite.

The La Huerta silt has a dark mahogany colour—deep Corinthian to dark Indian red. Although only 1·11% ferric iron oxide is present, saturation with halite produces a colour change akin to that caused by wetting of sediments. The constituents are sharp quartz grains coated with residual clay, and bottom currents are suggested by incorporated angular silt fragments of varied appearance.

The Fletcher is more warped than higher beds, and part of it has a lace-like aspect where tabular crystals of halite separated by anhydrite ribs replace a swarm of twinned gypsum crystals. Some wood-brown dolomite has been washed in near the junction with the Carlsbad reef. The top and front of the latter are marked by pisolites up to 2 in. diameter, and by fusulinids, both of which disappear towards the zone of interdigitating sandstones. A. L.

500.* Lateral Gradation in the Seven Rivers Formation, Rocky Arroyo, Eddy County, New Mexico. R. L. Bates. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, **26** (1), 80–99.—Measured exposures in Rocky Arroyo Canyon, 12 ml. north-west of Carlsbad, New Mexico, show that in the Seven Rivers formation (Permian), which was deposited in a shallow sea on the back-reef—lagoonal—side of the Capitan reef, there is lateral change of limestone and magnesian limestone into a 275-ft. section of gypsum with intercalated thin dolomitic layers. Illustration is provided of a 2½-ft. bed of porous calcitic limestone, containing reddish sediment, that passes into a considerably thicker bed of gypsum. The latter, presumably deposited as anhydrite, owes its superior thickness to the 40% increase in bulk following hydration. Precipitation of calcium sulphate took place nearest to the reef in early Seven Rivers time, and then progressively farther away from it.

Associated breccias of angular fragments that show no evidence of rolling or abrasion by waves, are regarded by R. L. Bates as occurring most prominently where drainage on the present land-surface is concentrated. They may be of modern origin, but Meinzer, Renick and Bryan think that the breccia at the top of the Seven Rivers gypsiferous member was of contemporaneous formation, possibly due to subsidence, and marks a disconformity. A. L.

501.* Problem of Well Spacing. Houston Geological Study Group. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, **26** (1), 100–122, with bibliography from 1931 to 1939 of 121 items.—In the development of oil-fields many factors cannot be controlled—for example, structure and porosity, permeability, initial temperature and pressure, composition of oil, gas, and water. Some degree of control, however, is possible over location and density of wells, and rate of production, and proper penetration of the productive section. The effect of water-drive and of free and dissolved gas should be conserved; and where both water-drive and free-gas cap are present, the wells should be completed so as to allow for expansion of the cap, but in such a way that the water, which is more effective in flushing out oil, will play the major part. If there is no water-drive, the wells should be completed in the lower part of the producing section in order to obtain maximum utilization of pressure from dissolved gas; and where there are interbedded bodies of shale, the lowermost parts of the pool should be depleted first. Generally speaking, properties most densely drilled have yielded the greatest relative share of total field recovery, but to some extent the densest drilling has been prompted in the most prolific parts of fields. Often the more rapidly fields are exploited, the less efficient are the processes of oil recovery. In a continuous reservoir, given sufficient time, there is no limit, apart from structure and other wells, to the area that may be drained by a single well. The number of wells drilled, therefore, should be determined according to the required rate of production and in keeping with the safe rate, so as to prevent coning and channelling of gas and water around the wells.

Gas–oil ratios tend to be kept down by slow production and by sealing of gas-bearing strata. With the latter purpose in view, determination of gas–oil contacts by analysis of mud returns is important. Bottom-hole pressure gauges, in use since 1930, give warning of rapid fall of pressure if withdrawal is in excess of encroachment by water-drive. Permeabilities of the producing formations, calculated from pressure and pro-

duction data on flow-tests are also significant; and productivity indices per pound pressure drop and specific productivities per foot of sand provide a sound basis on which the producing abilities of wells may be compared. Too great pressure reduction may result in distillate yields, since a hydrocarbon system existing as one phase may, owing to release of pressure, give rise to a two-phase system, in which case the liquid phase, with the most valuable constituents, may prove irrecoverable. Other points are that with low rates of flow, greater drainage radii are to be expected, while fine sands may possibly be flooded by encroaching water more quickly than coarse sands; and that after damage by coning prolonged shutdown sometimes leads to recovery.

The trend from 1931 to 1939 towards wider spacing and regulated production has been valuable from the points of view of conservation and total yield. At the beginning of the period J. R. Suman advocated that only wells sufficient to delineate a reservoir should be drilled, with addition only of wells necessary to complete the exhaustion. More recently L. L. Foley (1938) puts the same case, and emphasizes the desirability of producing slowly from a few initial wells, so as to determine the character of the water-drive. In the Salt Creek and Rock River fields of Wyoming, and at Cat Creek, Montana, expected total recovery was not augmented by additional drilling; and J. J. Zorichak has demonstrated that delayed drilling often furnishes a large proportion of dry holes, so indicating the efficiency of existing wells; this, of course, does not apply to lensing-sand reservoirs or to limestones with discontinuous porosity. In gas-drive fields **M. Muskat** (1939) concludes that little extra recovery from permeable sands would result from close-spacing; but that for very tight sands spacing should be close enough to obtain appreciable returns before well production drops below the economic limit. A. L.

502.* Viola Well-core from South Dakota. C. E. Decker. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, **26** (1), 123–126.—North of the Black Hills, South Dakota, the base of a 487-ft. limestone, at a total depth of 7728 ft., yields *Amplexograptus amplexicaulis* (Hall), *Climacograptus typicalis crassimarginalis* Ruedeman and Decker, and *Callograptus* sp. This seems to be the exact equivalent of a horizon 150 ft. above the base of the Viola limestone (Ordovician) in its thickest development of 927 ft. on West Spring Creek, Arbuckle Mountains. A. L.

503.* "Ortiz Sandstone" and "Guarumen Sandstone Group" of North-Central Venezuela. M. Kamen-Kaye. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, **26** (1), 126–133.—It is concluded that the Ortiz sandstone, dated by R. A. Liddle as Lower and Middle Eocene, is either within the Upper Cretaceous–Paleocene division on account of its association with Upper Cretaceous dark shales containing ammonites, etc., or of post-Paleocene age and unconformable upon, alternatively downthrown among beds of the earlier series.

South of the steeply folded area, with thrusting from the north, in which the Ortiz occurs, there lies on either side of the Rio Guarumen—a strike-stream—a broad zone of sandstones with silts and clays, of great thickness and simple structure, for which the name of "Guarumen Sandstone" is designated. Outcrops often show cliffs a few feet high and surfaces with ripple-marks which have up to as much as 10 cm. between crests. The sand is of pure quartz, with quartz cement and limonitic stain; and any felspar is altered to kaolin. Plant remains include leaves probably of *Cassia* and *Longifolia*, and sometimes give rise to lignites. Some of the clays yield marine molluscs apparently belonging to the families Arcidae, Tellinidae, and Ledidae, while Foraminifera are restricted to the arenaceous genera *Ammobaculites*, *Trochammina*, *Haplophragmoides* and a miliolid. There seem to be marine limestones near the base of the Guarumen with Orbitoididae of *Lepidocyclina* type, possibly belonging to the Upper Eocene–Lower Oligocene transition. If so, the Guarumen group may continue to a high Oligocene or Lower Miocene horizon.

The Guarumen sandstone provides a restricted suite of heavy minerals—zircon, rutile, tourmaline, garnet, none of which is abundant, along with occasional anatase and very rare chloritoid. The scarcity of these suggests that the beds were derived from a sedimentary source. For this Kamen-Kaye looks southwards to the ferruginous quartzite of the Rio Orinoco, lightly metamorphosed possibly under thermal rather than hydrothermal conditions, which might have supplied small consistent

amounts of garnet. In the north it is thought that the coastal schistose massifs were not uplifted to any important degree until Middle Miocene time. A. L.

504.* McLouth Gas- and Oil-field, Jefferson and Leavenworth Counties, Kansas. W. Lee. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, **26** (1), 133–135.—Closure of the McLouth anticline, in the Forest City basin, North-east Kansas, increases with depth, and the structural crest shifts south. Most gas is obtained from the McLouth sand at the bottom of the Pennsylvanian, and five wells also produce oil from this zone. Production extends far outside the area of closure, except where the sand contains clay. The weathered top of the Mississippian yields gas, and is locally saturated with oil, although none has yet been recovered. Porous dolomite in the undifferentiated Burlington-Keokuk limestone provides oil from four wells.

On 31st November, 1941, thirty-nine gas-wells had been drilled, with productions of a quarter of a million to 19 million cu. ft./day, whilst the total aggregate initial production of the oil-wells did not exceed 450 brl./day of oil of 24–25° Be.

Oil-saturated dolomite has been struck in the Hunton (Upper Devonian), and this suggests that the oil-source may lie below the top of the Devonian. The basal Devonian is water-bearing, resting on Maquoketa shale. A. L.

505. Geology of Avoyelles and Rapides Parishes [Central Louisiana]. H. N. Fisk. *Louisiana Geol. Surv., Bull.*, **18** (1940), 1–240.—Deposition on levees and lowlands by flood-waters of the Mississippi and Red rivers is described, and also the crevassing of the levees, and changes of course whereby great stretches of the rivers may be abandoned by the main stream, although kept open in part by tributary drainage entering the arcuate channels. Mississippi levees have a backslope of 6 ft./ml., and average about 3 ml. wide. Red River levees reach about a mile wide, and slope at about 10 ft./ml. Meander loops of the Mississippi have a maximum diameter of 7–9 ml., while for the Red river this is 2–3 ml.

In the Pleistocene, alluvial terraces taken as interglacial are separated by glacial epochs of entrenchment, the fourth and last of which carried incision to a depth well below the base of the recent alluvium. The Pliocene is missing, but the earlier Kainozoic history is also of fluvial deposits, under the accumulation of which from the shifting mouth of the Mississippi the crust was down-warped. Strangely enough, there seems to be a limit of crustal bending in each depositional cycle—of about 3000 ft. In Central Louisiana this applies to (1) Midway and Sabine (Lower Eocene) deltaics; (2) Claibourne to Vicksburg (Middle Eocene-Oligocene) and (3) Catahoula (Lower Miocene) up to *Heterostegina* marls. In Southern Louisiana Middle and Upper Miocene also aggregate 3000 ft., each; and both the Pleistocene and Recent deposits, where fully developed, have roughly the same thickness. Each 3000 ft. unit is built seaward along the monoclinal flexure of the preceding section. Principal marine advances took place in the Upper Catahoula, prior to the abundant incoming of *Rotalia beccarii*, which survives well in brackish water, and in the Fleming formation (Miocene), which contains, in the Lena member, pyroclastic material floated from a distance. Outcrops of the latter are either sulphur-yellow, or leached to a white colour with accompanying precipitation of siliceous caliche nodules from the ground-water. Common brackish molluscs from the *Potamides matsoni* Zone of the Fleming are illustrated.

Under the alluvial plain of the Red river, the Cheneyville oil-field, Rapides Parish, is localized over a piercement type of salt dome, above which there are major radiating faults, and secondary faults subparallel with the margin of the plug. All the faults cut the *Heterostegina* Zone of the Catahoula, but are pre-Quaternary. Production is from the Eocene, as in the larger, but closely comparable Eola field, in Avoyelles Parish, 3 ml. south of Bunkie, where oil-sands have been logged in the Cockfield, Sparta, and Wilcox. A. L.

506.* Eastern Venezuelan Fields Contribute to Record Yield. J. P. O'Donnell. *Oil Gas J.*, 12.3.42, **40** (44), 34.—During 1941 Venezuela's oil production amounted to 228,131,000 brl.—more than 10% of the world total. In 1939 the new eastern fields within a radius of 75 ml. in Monagas and Anzoategui gave 1·5% of the country's output, but in 1941 they gave 16%. Only one of the fields (Oficina) was of importance

in 1938. Jusepin, San Joaquin and Santa Ana were added to the producing list in 1939, and the rest—Guario, El Roble, Leona, Santa Ana (Texas), Santa Rosa and Santa Barbara—subsequently. Improved outlets for the crude are expected to improve the region's output.

Lagunillas and Tia Juana gave more than half of Venezuela's oil in 1941.

Tables show the crude-oil production of Venezuela by years since 1917, with the percentages it has contributed to the world totals, and the total and daily production by fields in 1940 and 1941, with the status of the wells at the end of 1941. G. D. H.

507.* Eastern Venezuelan Fields Raise Production; Lake Area Declines. Anon. *Oil Gas J.*, 26.3.42, **40** (46), 75.—During January 1942 the daily output in Eastern Venezuela rose 6000 brl., while that of the Lake fields fell by 42,119 brl./day. Tia Juana took first place with a monthly total of 5,584,625 brl., and altogether the Lake fields produced at the rate of 439,139 brl./day. In the east Santa Rosa's output was three times the December 1941 figure. Increases in January took place also at La Paz, Mene Grande, Mara, Quiriquire, Oficina, Jusepin, El Roble, Leona, and Guario. Shipping of oil began in the Mulata field.

A table gives the production by fields and companies in January and December 1941, and January 1942. G. D. H.

508.* Arkansas Smackover Lime Pools have Large Sour-gas Reserves. Anon. *Oil Gas J.*, 26.3.42, **40** (46), 250.—Development of the Smackover lime-fields in Southern Arkansas began in 1937 at Schuler. Soon discoveries were made at Magnolia, Village, Buckner, Atlanta, Dorcheat, McKamie, and Macedonia, the last three being mainly gas-distillate fields. All lie south of a major fault system which runs south-west to Rodessa. Early in 1942 a field was found north of the fault at Midway, in which area the Smackover had previously been considered tight and barren.

All the fields are on elongated domes, generally trending north-west to south-east and tending to be *en echelon*.

The McKamie field now covers 3000 acres and gives mainly distillate, although there is a little oil in the bottom of the pay. The original pressure was 4365 lb./in. The pay is at 8750–9070 ft., averaging 105 ft. thick, with an estimated possible recovery of 225,000 million cu. ft. of gas and 18 million brl. of oil. Dorcheat, covering 2000 acres, has reserves of 70,200 million cu. ft. of gas, 17 million brl. of oil and 4,050,000 brl. of distillate. Macedonia covers a similar area, and has rather larger reserves of gas and distillate.

The Smackover lime-pools are believed to be under water drive. G. D. H.

509.* Strategic Location of Wells in Flank Sands on Piercement-Type Salt Domes. Anon. *Oil Wkly*, 4.2.42, **104** (10), 17.—The wells around a salt dome are generally located in a narrow band, 300–500 ft. wide, although the productive zone is occasionally three-quarters of a mile or more in width. Usually one flank is more prolific than the other. Individual sands range 10–100 ft. or more in thickness, and there may be as many as twenty sands, which often dip at 20–60°. They may end at the salt or at fault gouge, while some may end a short distance from the salt. Irregular radiating faults frequently affect the beds, the fault-planes being at times 25–50 ft. wide and giving rise to separate reservoirs. The oil-sands are usually highly porous and permeable, with a low gas–oil ratio. Hydrostatic head is the common driving force for the oil.

The various possible ways of testing the flanks of salt-domes satisfactorily are briefly discussed, and as regards wild-catting it is suggested that wells may be deepened to new sands, or directionally drilled towards or away from the salt in search of new sands; wells may be drilled to test a new segment, or on domes without previous flank production. The aim should be to pierce as many sands as possible so that oil may be produced from the sands one at a time by small workover jobs. G. D. H.

510.* San Jacinto Strike Encourages Coast Wilcox Drilling. R. Reaves. *Oil Wkly*, 9.2.42, **104** (10), 22.—Recently a producer was completed in the Wilcox of the Mercy area of the southern tip of San Jacinto County. Previously a number of wells, mainly Cockfield tests, had found oil and gas shows, but no commercial production in this county.

The Mercy area has been seismographed, and the structure, probably a faulted anticline, is believed to run north-east to south-west for several miles.

The well was drilled to 8321 ft. and perforated at 8273–8279 ft. A 24-hr. test gave 583 brl. of 38-gravity oil through a ¼-in. choke with a gas–oil ratio of 771. The find is on the same line as Shepherd, Segno, Ace and Joe's Lake to the east.

G. D. H.

511.* Prospecting Tactics in a Total-War Economy. E. E. Rosaire. *Oil Wkly*, 9.3.42, **105** (1), 13–18, 32.—Nine steps seem to be involved in a co-ordinated prospecting programme: (1) The collection of all pertinent prospecting data, and information regarding the accessibility of markets, communications, leasing, and the prospecting history. (2) Geochemical reconnaissance, possibly on a mesh of one half mile. (3) Consideration of the results of geochemical reconnaissance, and the selection of favourable anomalies for detailed work, having regard to the geology and areal extent. (4) Detailed geochemical work using a grid less than one-quarter or even less than one-eighth of a mile. (5) Consideration of the detailed geochemical work, and selection of the most suitable anomalies. (6) Use of the reflection seismograph to obtain structural information down to depths well below probable drilling depth. (7) Examination of reflection data for closure, wedging, faulting, and variation of structure with depth. (8) Slim-hole drilling to obtain lithological, hydrocarbon, micropalaeontological, and electrical logs. (9) Examination of the exploratory hole data to select sites for production tests and to predict points for coring, production, etc.

G. D. H.

512.* Wells Drilling off 40% since January 1st. Anon. *Oil Wkly*, 9.3.42, **105** (1), 33.—On 1st March, as a consequence of lack of materials in January and February, only 2063 wells were actually drilling. On 1st January there were 3453 wells, and on 1st February there were 2,659 wells drilling. The outstanding curtailment was in Illinois, where there were seventy-one on 1st March and 298 on 1st January.

Tables give by states and districts the numbers of rigs in operation on 1st February and 1st March, 1942, and on 1st March 1941, details of the activity on 1st March, 1942; the monthly completions for January and February 1942, and for February 1941; and the types of completions in January and February 1942.

G. D. H.

513.* Second Well Completed in Guarico State. Anon. *Oil Wkly*, 9.3.42, **105** (1). 48.—Mercedes 2 has been completed at a depth of 5586 ft., giving on test, 363 brl. of 35° A.P.I. oil/day through a ¼-in. choke. It lies about 130 ml. west of the El Roble field, and ½ ml. south of Mercedes 1, which was abandoned last summer as non-commercial.

G. D. H.

514. Cephalopods from the Drummuck Group of the Girvan District. C. Teichert, *Trans. Geol. Soc. Glasgow*, 1940, **20** (1), 103–115.—The description of *Zitteloceras costatum* and *Neumatoceras drummuckense* from the Ashgillian (Upper Ordovician) of Scotland constitutes the first record of these well-known American genera from Europe. *N. drummuckense* is closest to *N. milleri* Foerste from the probably pre-Richmond base of the Bighorn formation in Wyoming. Another Girvan species, *Diestoceras lamonti*, does not have close affinities with any American member of the genus, which ranges from Black River to Richmond, but is most nearly related to *D. acuminatum* Strand from Etage 5a of Oslo. Teichert's *D. scoticum* resembles *D. isotelorum* Strand from horizon 4dγ and certain species from Percé, Quebec, and Anticosti. A fragment described as *Cyrtorizoceras*? sp. ind. from Girvan may even belong to *Manitoulinoceras* or *Richardsonoceras*, at present well known from the Ordovician of North America.

A. L.

515. Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma. Part 6. Townships 28 North, Ranges 10 and 11 East, and Township 29 North, Ranges 9 to 11 East. H. B. Goodrich, L. E. Kennedy, and O. Leatherock. *U.S. Dept. Inter., Geol. Surv. Bull.*, 900-F, 1940, 209–236.—Over 1000 wells have been drilled in this part of North-eastern Osage County, and production is from eight zones at depths of from 475 ft. to about 2000 ft. These are in Siliceous lime (Ordovician), at the Missis-

sippi lime–Burgess sand unconformity, and in six Pennsylvanian sands, among which the Wayside, Weiser, and Peru are the most important. The regional dip, as observed from the Oswego lime (Pennsylvanian), is westward at 25 ft./ml., interrupted by domes that become more pronounced at depth and that have crests offset from their positions in the surface structures. Deepening and extension of existing fields are indicated, but few entirely new localities deserve to be tested. In some localities repressuring is being proceeded with. A. L.

Drilling.

516.* **Drilling Methods at Chapel Hill.** T. P. Sanders. *Oil Gas J.*, 12.3.42, **40** (44), 37.—Universal difficulties have been found in drilling the Chapel Hill field of Smith County, East Texas. A surprisingly large number of the wells, ranging in depth from 5700 to 8500 ft., have experienced very costly fishing jobs, despite the fact that all ordinary precautions have been taken to guard against sticking of the drill-pipe. Experience gained in the 3½ years since the first well was completed has led to the introduction of remedies that appear to be successful in overcoming the most serious problems, but as yet there is no general acceptance of the innovations, and comparatively little uniformity in the practices of the drilling firms participating.

Principal trouble is credited to key seating of the hole by the drill-pipe, particularly in the alternating lime and shale sections. To solve this problem one company followed the practice of increasing the size of the hole drilled down to the Austin Chalk. Thus, the new programme requires no additional casing, gives the same protection to the fresh-water sands, and provides a much larger hole through the troublesome portion of the strata.

There are several ways in which a larger hole serves to eliminate key seating. First, the greater clearance minimizes the effect of small direction changes if the general course of the hole is vertical, and the result is that lateral forces tending to force the drill-pipe against the walls of the hole may be eliminated. Second, the reduction of fluid velocity due to greater area helps to prevent enlargement of the hole in the soft-shale intervals. Third, if a key seat is formed, there will be less likelihood that the drill assembly will be forced into it while the pipe is being pulled. The practice seems to be a success.

Some operators in the Chapel Hill field have successfully avoided stuck drill-pipe without resorting to the method described above. As a rule these individuals depend on careful pulling of the pipe to avoid getting stuck. All holes drilled in the field appear to have tight places where the pipe will become stuck if pulled rapidly. The fact that it can be worked through these places if care is taken in pulling supports the belief that key seating is the cause of the trouble.

Practically all wells in the field have been drilled with carefully controlled mud; hence it appears unlikely that stuck pipe has been caused by thick filter-cake on the walls in any great number of cases. Water-loss tests are performed regularly at most rigs, the mud is kept alkaline, and the weight is maintained at approximately 10·2 lb./gal., with viscosity usually in the neighbourhood of 24. One operator reports good results from use of common baking-soda in treating mud that has become cement contaminated. It is stated that cement bubbles are quickly knocked out by addition of the soda.

The number of bits required for an 8300-ft. well indicates the hardness of the lower formations. Even when the 12¼-in. hole was drilled to 2800 ft., the record of a typical well shows that two 12¼-in. rock-bits were required for drilling that interval, as compared with thirty-six 8¾-in. rock-bits from 2800 ft. to the total depth. However, one operator at present drilling expects to complete his well with a total of twenty-eight bits, which would represent a considerable reduction in rock-bit costs. Dual slim-hole completion is discussed. A. H. N.

517.* **High Gas Pressure Controlled.** N. Williams. *Oil Gas J.*, 26.3.42. **40** (46), 229.—Abnormal gas pressures, among the highest yet recorded in the lower Texas Gulf Coast district, and caving shales combined to create unusually difficult conditions for a company in the drilling of its 2 Stillwell, recently completed as the discovery well of Yegua production in the Alice field, Jim Wells County. On several occasions operators were threatened with serious blow-outs and loss of hole, and in the completion

of the well, the drill-pipe, stuck by bridging and caving of the shales, was left in the hole because of the hazards involved in attempting to recover it under existing high pressures.

The operations involved in drilling and controlling the well are briefly described.

A. H. N.

518.* Caliper Logging. C. P. Parsons. *Oil Wkly*, 2.3.42, **104** (13), 23. *Paper Presented before American Petroleum Institute.*—Caliper logging is a practice of measuring the variations in diameter of the open hole. The number of cases where caliper logging is of service is great, and the paper details some of them. Starting with the grass roots in a well to be drilled in the Gulf Coast, for instance, the first problem in which the diameter of the hole is involved is where to set surface casing. The physical measurement obtained by caliper logging not only assists in determining the proper depth for setting surface casing, but is the only way of determining how much cement will be required to fill the space behind the casing. It may not be necessary to run a caliper log in every well for this purpose, but enough of them could be run to establish a casing and cementing programme in the early development of a field.

Another problem is the failure of tool-joints due to excessive wobble of the drill-string. This has a definite relation to the size of the open hole. Future progress in deeper drilling is partly dependent on solving this problem. So far the problem has been studied from the standpoint of materials and design used in the drill-string. Caliper logging now makes it possible to study the relation of the varying sizes of open hole to the wobble of the drill-string, and to study results of various drilling techniques. Other problems are connected with completion, gravel packing, plugging back, etc.

The caliper is run into a well with the arms in closed position, and when it reaches the bottom of the well or some other level where caliper logging is to begin, the arms are released by an electrical means and opened by spring tension. The four arms are mechanically independent of each other. The caliper is run into a well on an electric cable. When it is pulled upward through the open hole, the four arms ride gently against the wall of the open hole. The variations in diameter of the well are measured by electrical means connected to the upper ends of the arms, and the recording is made directly in inches at the surface. Measurements are obtained at rates up to 100 ft./minute, depending on conditions in a well. It is not necessary to remove the drilling mud, oil, or water from the open hole, as they do not affect the operation.

Several typical caliper logs are given as illustrations. An interesting case is one of a 10,000-ft. well made before running in casing. The purpose of running this log was to determine the volumetric capacity of the space which would be behind the casing, so that the proper amount of cement could be used to cover the Haas sand and Tate sand located upward in the hole, and which later may be produced by perforating the casing. According to calculations based on the size of the bit which drilled the hole and the O.D. of the casing, it would require only 400 sacks to fill the annular space up to the proper level. According to caliper measurement, it required 1250 sacks. Previous wells drilled in the same field failed to get proper fill-up, and several squeeze jobs were necessary to repair a condition which was attributed to channelling. The caliper log shows that the 525 sacks plus the usual amount donated to the hole would scarcely reach the upper sands. A thermal log taken after the casing was cemented with the 1250 sacks calculated from the caliper log, showed that the cement reached its intended height.

A. H. N.

519.* Abandoned Wells Can Be Reclaimed. F. R. Cozens. *Oil Wkly*, 6.4.42, **105** (5), 34.—Methods of plugging abandoned wells, to prevent the entry of water to the pay, with a view to their reclamation later, are described. After the final section of casing has been removed from the hole, a block of wood about 4 ft. in length, circular in shape, and with a diameter slightly larger than that of the bore-hole is brought to the job. Lengthwise, through the centre of this block or core, a short piece of pipe is driven (3 ft. is the average length). The core, with pipe extending upward, is then pressed into the mouth of the salvaged well, and driven down until the top of the pipe is about 3 ft. below the surface of the ground. Earth is firmly tamped down upon this core, which now becomes a bridge, until the hole is filled level with the surface, and the abandonment job is completed.

Later, when, in the course of months or years, it is decided to reopen this abandoned

well, the recovery operator locates the spot, and by digging away the tamping, uncovers the pipe. A plumb-bob and line inserted in the pipe-top reveals the exact centre of the old well, and drilling equipment is rigged accordingly. The wood plug or core is easily broken up by the drill, and from thence on, the hole is usually found remarkably free of spoil. In a test reopening of thirty-three abandoned wells in South-eastern Ohio, the amount of cavings or spoil averaged less than 40 ft./1000 ft. of hole. Ten of these wells had been abandoned for five years and longer. Where pieces of former pumping equipment are known to be in the hole, the reopening problem is more difficult; but if a record of the well, with accurate measurements, has been kept, it is usually possible to force the obstruction into the walls with the drill, and after so doing use casing of smaller diameter. Some operators equip such wells with heavy-weight 2-inch tubing, bedded in cement at the top of the pay-sand. A. H. N.

520.* **Central Mud Plant Provides Drilling Fluid for Marine Locations.** G. B. Nicholson, *Oil Wkly*, 13.4.42, **105** (6), 15–18.—In marine locations, often isolated, and where procuring fresh water is costly and inconvenient, mud requirements are effectively supplied for the Texas Company by output from a mud plant and storage system located in a central site, and furnishing incidental mud requirements of rigs drilling in waters of the bays and inlets of the region. Special barges deliver mud of specified weight and viscosity to rigs, relieving drilling crews of mixing, as well as eliminating expense of providing fresh water supplies and special mud-storing installations on drilling barges.

Products of the plant consist of lighter muds or clays, used in drilling shallow or low-pressure wells. Chemical and specialized muds are mixed on drilling barges as conditions warrant, and all barges are equipped for mixing and storing such muds when needed. Light drilling fluids made of native clays and having characteristics adaptable for ordinary conditions, however, are stored in the terminal, and have a widespread use. Mobility of mud-delivery barges allows rapid movement to rigs where mud is shipped, and appropriate pumps for emptying tanks, moving mud to barges, and transferring it to drilling barges are provided. Excavation for, and conveying of, mud by a 400-ft. belt conveyor are described, with details of mud processing and storage.

When the plant is in full operation, six men are employed to dig and mix mud. Four men work in the excavation pit near the belt, shovelling mud and placing large lumps on the conveyor for carrying to the cutting machine; one man operates the engine governing the cutting and the pumps, whilst the sixth is stationed at the strainers to keep the meshes clean and uncongested and to test the fluid prior to its storage. When operating at full capacity, the plant produces about 350 brls. of 10¾ lb. mud daily.

Cost of the mud is low, in recent production amounting to only 9½ cents./brl., although it is estimated that present cost has increased to 11 or 12 cents/brl. Initial investment was small, and upkeep is kept at a minimum by operating the plant only at intervals sufficient to keep the tanks filled. Mobility of barges permits rapid and economical distribution of mud to rigs, relieving drilling crews of mixing light mud, leaving them only the task of preparing special muds for extrme drilling conditions.
A. H. N.

521.* **Directional Drilling Deflects Hole into Productive Zone.** C. C. Pryor. *Petrol. Engr*, March 1942, **13** (6), 31–32.—Failure to find production on a lease in an East Texas field recently led one operator to resort to directional drilling to find a productive zone. Although deflection of the hole from an unproductive to a productive portion of a lease is common practice in these days of modern scientific drilling, the cost of an abandoned hole, which may include casing lost in the hole, besides the cost of drilling machinery and materials and the scarcity of labour, is entirely prohibitive in the present national emergency.

As a result of deflecting the direction of the well, there was no lost casing, drilling time, or machinery. There was an increase in drilling time of approximately 14 days, plus the cost of directional drilling service; but final completion of the well as a producer at a cost of approximately one-third more than a vertically-drilled well was regarded as ample compensation.

The procedure and results are given in some detail, and are illustrated. A. H. N.

522.* Orientation of Conventionally Recovered Cores. W. A. Sawdon. *Petrol. Engr.* March 1942, **13** (6), 46.—Polar core orientation is a magnetic method based on the fact that a certain amount of polarity from the earth's magnetic field has been acquired and retained by many formations. This phenomenon is especially true of formations such as sand and shale, the materials becoming oriented when settling into beds, and probably becoming further magnetized during the long period extending from the time they were laid down to the present. Utilizing this polarity of cores that have been taken in formations of this kind, the magnetic north and south of the core is determined with reference to the dip and strike, as shown by the bedding planes of the core, and the true direction of the dip and strike then computed.

There are, however, many cores from formations such as pure limestones, diatomites, anhydrites, and dolomites that show no polarity. Cores taken exclusively from such formations cannot, of course, be oriented by the polar method. In some cases, however, limestones will have shale-breaks, and cores containing such shale partings will frequently have sufficient polarity to be oriented.

Either old or new cores can be tested by polar core orientation, so long as the cores are in good condition. Fresh cores are, of course, preferable, but so long as a core has not been exposed to magnetic influences sufficient to distort or destroy the residual polarity, reliable orientation can be made. Cores several years old have been tested with good results. The core must disclose a clearly defined bedding plane, and should be not less than 1 in. diameter and 2½ in. long. It can be taken with any type of coring equipment, but its top should be marked as soon as recovered, to avoid mistakes. After marking the dip and strike on the smooth, cylindrical core, it is placed in the core-holder and, after being accurately centred in direct alignment with the magnetic system, is rotated by means of a driving-gear that revolves the core 360° in synchronism with a drum, on which sensitized paper records by reflected light the magnetic reaction caused by the polarity of the core. This record is shown by a solid line on a chart. The core is then reversed end for end in the core-holder and rotated in the opposite direction, during which the "reverse run" is recorded with a broken line. When the record curves are flat and show no resemblance to a sine curve, the core is weakly polarized, and will often have to be re-run with the core closer to the magnet, in order to pick-up the weak field.

To interpret the curves, an arbitrary reference line is used as the abscissa, and a "resultant curve" plotted by subtracting graphically the reverse curve from the forward run. The purpose of this subtraction is to cancel out the effect of susceptibility. The resultant curve is then read by locating a 180° segment between the slopes of the curve, this segment being taken parallel to the abscissa. Magnetic south is at the intersection of this segment with the down-slope of the curve, magnetic north being at the intersection with the up-slope. As the beginning of the curve corresponds with the zero line marked on the core, the magnetic south is the number of degrees measured from the left end of the curve to the point marked "South." A. H. N.

523.* Factors Influencing Electrical Resistivity of Drilling Fluids. J. E. Sherborne and W. M. Newton. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1466, 1–17.—The resistivity of the drilling mud and its filtrate can appreciably affect the electrical logs. Thus the self potential curve for a given well showed negligible variation with depth, using a mud of 0·8 metre-ohm resistivity, but a second run using a 2·0 metre-ohm mud produced a much-improved log.

Tests on five muds commonly employed in California showed the following features: (1) The effect of raising the temperature from 80° F. to 180° F. is to decrease the resistivity of the mud or filtrate by about 50%. The same is roughly true for chemically treated muds. (2) In most cases the resistivity of the mud approximates closely to that of its filtrate. (3) The change in mud resistivity caused by the addition of a given amount of a chemical is not the same for each mud. Electrolytes lower the resistivity, and so tend to reduce the sensitivity of the logs, whereas non-electrolytes have little effect. (4) The resistivity of a native mud is approximately that to be expected from its sodium chloride content. (5) Weighting materials such as barytes and limestone tend to raise the resistivity of drilling mud, while cement and the sodium bicarbonate used for treating the cement-contaminated mud reduce the resistivity.

G. D. H.

524. Patents on Drilling. W. J. Travers, Jr. U.S.P. 2,274,756, 3.3.41. Appl. 23.9.40. Cementing tool on tubular members.

A. D. Stoddard. U.S.P. 2,274,940, 3.3.42. Appl. 5.9.39. Squeeze cementing of wells device, including a packer.

J. H. Schreiber. U.S.P. 2,274,271, 3.3.42. Appl. 3.6.40. Joint breaker and cathead arrangement.

A. Boynton. U.S.P. 2,275,418, 10.3.42. Appl. 17.7.39. Threadless drill-pipe.

J. Neufeld. U.S.P. 2,275,456, 10.3.42. Appl. 7.6.39. Method and apparatus for radioactive investigation of drill-holes.

D. Scaramucci. U.S.P. 2,275,473, 10.3.41. Appl. 11.7.39. Well-cementing apparatus, consisting of an electrical sounding device for use in liquids.

D. Scaramucci. U.S.P. 2,275,474, 10.3.42. Appl. 13.7.39. Measuring apparatus for determining the depth of oil-wells or the like.

H. B. Robbins. U.S.P. 2,275,655, 10.3.42. Appl. 16.11.40. Means for cementing wells using a retainer.

R. T. Cloud. U.S.P. 2,275,736, 10.3.42. Appl. 14.2.40. Seismic wave velocity well logging.

R. E. Fearon. U.S.P. 2,275,747, 10.3.42. Appl. 27.12.39. Well-survey method and apparatus using an ionization chamber.

R. E. Fearon. U.S.P. 2,275,748, 10.3.42. Appl. 28.3.40. Well-surveying method and apparatus using α-particles.

W. A. Abegg. U.S.P. 2,275,813, 10.3.42. Appl. 3.10.39. Bushing supporting means for oil-well rigs.

J. A. Zublin. U.S.P. 2,275,832, 10.3.42. Appl. 29.1.41. Apparatus for rotary drilling consisting of a bit.

S. C. Fietinghoff, A. R. Maier, C. F. V. Loozen. U.S.P. 2,275,895, 10.3.42. Appl. 11.1.40. Oil-bath rotary.

F. L. Le Bus. U.S.P. 2,275,911, 10.3.42. Appl. 14.2.41. Retriever tool for oil-wells.

R. C. Baker. U.S.P. 2,275,937, 10.3.42. Appl. 11.1.41. Cementing device for well casing.

R. C. Baker. U.S.P. 2,275,938, 10.3.42. Appl. 11.1.41. Control-valve (for circulating joints).

R. C. Baker. U.S.P. 2,275,939, 10.3.42. Appl. 4.3.41. Casing scraper with sliding blades.

R. O. Childers. U.S.P. 2,275,946, 10.3.42. Appl. 16.5.41. Device for removing casing sections.

E. F. Hannon, Jr. U.S.P. 2,275,960, 10.3.42. Appl. 17.6.40. Fishing apparatus for well tools.

J. E. Brautly. U.S.P. 2,276,016, 10.3.42. Appl. 22.3.40. Hydraulic well-drilling apparatus for rotating, raising and lowering a drill-pipe.

C. E. Werensch. U.S.P. 2,276,075, 10.3.42. Appl. 14.10.39. Drilling-fluid using comminuted magnetic solids.

R. R. Bloss. U.S.P. 2,276, 561, 17.3.42. Appl. 5.6.39. Rotary drilling-machine.

C. H. Johnson. U.S.P. 2,277,110, 24.3.42. Appl. 31.12.38. Method of determining where pipe is stuck in well.

C. E. V. Stone and A. E. Johnson. U.S.P. 2,277,188, 24.3.42. Appl. 12.8.39. Portable pipe-straightener.

A. M. Graham. U.S.P. 2,277,397, 24.3.42. Appl. 15.1.40. Hose and hose-connector construction.

P. F. Murray. U.S.P. 2,277,500, 24.3.42. Appl. 20.9.39. Casing or drill-pipe spinning rope.

P. F. Murray. U.S.P. 2,277,501, 24.3.42. Appl. 28.12.40. Slush-pump piston.

L. A. Courter. U.S.P. 2,277,510, 24.3.42. Appl. 2.1.41. Cementing head in combination with a well-casing.

W. F. Carothers. U.S.P. 2,277,580, 24.3.42. Appl. 28.7.41. Combination wash-over and cutting tool. A. H. N.

Production.

525.* Illinois Production Depends on High Discovery Rate. W. V. Howard. *Oil Gas J.*, 26.2.42, **40** (42), 42.—During five years 118 new fields have been found in Illinois, and the production rose almost to 15,000,000 brl. in July 1940, with a decline to about 5,000,000 by the end of that year. A number of discoveries in 1941 raised the figure to over 12,000,000 brl./month, but the production is now nearer 10,000,000 brl.

Fifty-seven of the 118 fields have fewer than ten producing wells, and until the end of 1940 80% of the oil came from eleven major fields.

The first major discovery was Clay City, followed quickly by Noble. Centralia and Louden also were discovered in 1937, although they were not of importance in that year. Centralia proved its potentialities in the middle of 1940, when, with Louden and the other 1937 discoveries, it gave 5,700,000 brl. of oil. The old fields were then giving about 3,000,000 brl./month in December. Salem was the only major producer found in 1938, and almost immediately it became an important factor, at its peak topping the 6,000,000 brl./month mark. It declined quickly to less than a third of its peak.

The 1939 discoveries were some months before becoming important—Tonti, Griffin, Keensburg and Dundas. These were developed slowly, and the same is true of New Harmony. As a consequence they have not declined markedly.

Hoodville developed rapidly in 1940. Benton, Rural Hill, Johnsonville, and Parkersburg had rapid rises, and were responsible for 25% of the Illinois output at the end of 1941.

Graphs show the Illinois production in the period 1937–1941, with the discovery date and production of the major fields. G. D. H.

526.* South Jennings Distillate Plant Features High-Pressure Control. N. Williams. *Oil Gas J.*, 19.3.42, **40** (45), 39.—Production of the field is obtained from three deep sands, one at 8600–8700 ft., the second at 8800 ft., and the third at 9500 ft. Gas is being returned only to the shallower horizon, in which pressure is from 3200 to 3250 lb. Pressure of the 9500 ft. sand is above 5200 lb., as recorded at well-head, and is one of the highest pressures yet encountered on the Gulf Coast. This sand is being drawn on at present to supply additional volume of gas above cycling needs that is required to meet gas sale demand. The 8800-ft. sand is not producing at present, but will be used later to supply gas-sales demand.

There are three producing wells for the 8600-ft. sand and two for the 9500-ft. sand. Separate 4-in. flow-lines for each lead directly from the wells to the plant. All production is controlled through a central choke and regulator installation at the plant inlet. Each well is equipped with a double-acting pressure-controlled valve installed on the flow-line at the christmas tree, which operates to close the well in the event of any increase or decrease in back pressure from fixed limits. To shut in any producer it is only necessary to close the control on that particular well at the central regulator station. A rupture in a flow-line, causing a decrease in the pressure on the line, would likewise automatically shut in the well.

All flow-lines discharge into a common header to the plant intake line. Reducing regulators on the 5200-lb. flow-lines from the two 9500-ft. sand wells ahead of the header effect an initial fall in pressure of this gas to equalise with the 3200-lb. gas from the 8600-ft. sand-wells. Mixing of the expanded high-pressure gas with the somewhat warmer normal 3200-lb. gas not only lessens the chance of freezing that might result in expansion of the high-pressure gas, but also cools the 3200 lb.-gas.

The working data of the plant, including pressures, temperatures, quantities of fluids, and features of design, are described and illustrated. Items of equipment such as pumps, control instruments, and prime movers are also described. Plant power is derived from steam, and cooling water is obtained from deep wells.

A. H. N.

527.* **Thermal Logging of Producing Oil-Wells.** C. R. Dale. *Oil Gas J.*, 19.3.42, **40** (45), 49. *Paper Presented before American Petroleum Institute.*—The geothermal gradient varies in different areas and, in fact, may vary in different parts of the same structure. Also there is evidence to show that the geothermal gradient may not remain throughout the producing life of a field.

The normal geothermal gradient of a producing well is subject to change from a variety of conditions which may exist at points in the well. The anomalies recorded in a thermal log are indicative of these conditions. An interpretation of the log in the light of all other available information concerning the well shows the nature of the conditions and suggests the remedy or manner of taking advantage of them.

A number of different temperature-recording instruments have been developed for use in oil-wells. In general, they are of two types: those which record the temperature at successive stations, the instrument being held stationary in the well during recording, and those which produce a continuous record while the instrument is being lowered or raised at a constant controlled speed. Requirements of such instruments are: minimum thermal lag, sensitivity to temperature change of 0·2° F., and accuracy to within 1° F. from actual temperature. A photographic instrument which can be run on a piano wire at a speed of 2000 ft./hr. utilizes the twisting moment of a bimetallic helical coil, which, on change of temperature, winds or unwinds to a variable degree, and thus changes the length of a beam of light on a photographic plate. The image is later projected and magnified by a special projector.

In interpreting the data, each well must be considered as an individual problem, and all other information pertaining to it should be correlated with the temperature record in making interpretations. Well conditions under which the temperature record is taken are often as important as the accuracy of the recording instrument. Careful control of the well conditions must be exercised in order that the anomalies may be localized and developed in sufficient magnitude.

Where it is known, the normal geothermal gradient for the field can often be used as a basis for making an interpretation of the anomalies observed in the record. However, owing to the variations in geothermal gradient that may occur in various parts of the structure or during the producing life of the field, it may be necessary to make two traverses, one while the well is flowing, and the second after the well has been shut in for a period of 24 hrs. This practice has produced excellent results in locating the source of water, gas, and oil production, and in tracing the migration of fluids between zones. Each of these troubles is discussed separately.

A. H. N.

528.* **Automatic Tank-Battery Control Simplifies Lease Operation.** H. F. Simons. *Oil Gas J.*, 26.3.42, **40** (46), 227–228.—Use of a centrally located tank battery for the production from a large group of wells greatly increases the efficiency of the operation. Through the installation of automatic controls, the pumper on a lease in the Burbank, Oklahoma, field is allowed more time for duties away from the tank battery. The installation described includes ten tanks of 1000 brls. capacity each, and handles approximately 4600 brls. of oil/day.

Principal advantages of such an automatic system are that it fills the desired tank and automatically switches the production to the next empty tank, and so on, until all tanks have been filled. The cycle must then be automatically repeated, as some of the tanks will have been emptied into the pipe-line in the meantime. The system must also provide for the selection of a particular tank to be filled, and must have some reserve space for an emergency when all operating tanks happen to be full.

Through the installation of an electric control system, it is possible to fill and empty the tanks of a certain lease without any danger of overflowing the tank, or backing oil up into the separator, or losing any production. It is totally and completely automatic, and, so far as is known, is the only system of its kind in existence. Principal parts of the system are high- and low-limit automatic liquid-level control switches, electrically operated hydraulic valves and holding circuit relays, and a master control panel. These are described and illustrated. A. H. N.

529.* Improvements in the Treatment of Crude Oil-Water Emulsions. R. C. Buchan. *Oil Wkly*, 2.3.42. **104** (13), 27. *Paper Presented before American Petroleum Institute.*—The theory of treating oil-field emulsions when reduced to its simplest concept shows that two things must be done, *e.g.*, first, the water globules must be coalesced; and, second, the water and oil must be separated. The main factors that affect the first include: (1) the physico-chemical conditions, (2) the temperature, (3) time.

Assuming that coalescence is practically complete, the main factors that affect the second include: (1) the degree of agitation in the settling chamber, (2) the temperature, (3) time.

The companies which manufacture treating chemicals have maintained a vigorous research programme in recent years, and better chemicals are available than at any previous time. Some of this work is necessarily done in field laboratories, often housed in trailers, in order that fresh emulsions can be studied on the lease. These newer chemicals have been a help in several ways. It has become possible, in cases where it is desirable, to eliminate heating in several fields by using suitable treating compounds. They have generally reduced the time necessary for the completion of their action on emulsions, thereby reducing the size of settling tanks; or, in existing plants, they obtain a lowering of the impurities content of treated oil. There are some physical and mechanical problems in treating that can never be overcome by chemical means; but, on the other hand, it is thought that too often the chemical consumption is criticised while equipment design weaknesses that can be corrected are disregarded.

The author discusses the improvements made during the last several years in the art of handling and treating oil-field emulsions. These improvements include wider dissemination of knowledge of the subject, better chemicals, and new equipment, most of which was designed for this particular work. The definite but very limited present application of superdehydration and desalting in the field is summarized, the separation of gas in emulsion-treating plants is briefly discussed and the need for continuous study pointed out. A. H. N.

530.* Multiple-Zone Completions. E. O. Bennett. *Oil Wkly*, 9.3.42, **105** (1), 22. *Paper Presented before American Petroleum Institute.*—Multiple-zone completions may be made with more than two zones producing simultaneously into the same well. In this discussion only two such formations have been considered, and the equipment discussed has been designed for and limited to dual completions. The same principles and practices developed for dual completions may be applied to triple-zone completions. After a brief discussion of the problem in general, pumping of multiple-zone wells is discussed in detail. Dual pumping wells may be placed in several classifications, as follows: (1) A single pump and packer installation where the formations above and below the packer are pumped intermittently by the same pump. (2) A double pump with single or double prime mover where two zones are pumped simultaneously. (3) A single pump in one of two zones with natural flow from the other. (4) The gas lifting of two zones simultaneously. (5) The gas lifting of either of two zones while pumping the other. (6) The pumping of one zone while injecting gas into the second. (7) The gas lifting of one zone while injecting gas into the other. Each of these systems is discussed.

The completion steps taken in multiple-zone wells are discussed and the equipment used described and illustrated. When producing a dually completed well, care should be used to see that rates of flow from an upper sand do not occur with velocity sufficient to cut the tubing by a jetting action of fluids through the upper zone perforations. The use of a synthetic rubber sleeve over the tubing opposite such entrance ports will protect it from cutting out.

A summary of the advantages of multiple-zone completions, properly carried out by qualified operators, is set out: (1) Dual completions save approximately 50%

of the steel required to drill two separate wells to the corresponding zones. During the war emergency this steel is needed. (2) Dual completions will, in certain strategic areas, permit the most oil to be recovered per ton of steel used, and will help to keep up allowable requirements, so badly needed at this time. (3) Two-zone completions will permit the draining of thin sands which would otherwise not produce enough oil to justify the drilling of a well. (4) An edge-well that would not be drilled in a single zone can often be completed in a two-zone area and produce large volumes of oil that would ordinarily be left irrecoverable. (5) The drilling time and wear and tear on drilling equipment are reduced by approximately one half by the use of dual completions. This effects a corresponding saving in the completion costs of the wells drilled. (6) Multiple-zone completions greatly reduce the cost of marine drilling where several zones may be reached from a single derrick location. (7) The pumping of multiple-zone completions has been successfully carried out, and will permit such wells to be operated in separated sands long after the flowing stage has passed. (8) In a field where pressure maintenance is carried out, the use of multiple-zone completions provides many more locations for gas injection than would otherwise be available. A. H. N.

531.* Swabless Method Speeds Up Routine Well Completions. G. M. Wilson. *Oil Wkly*, 9.3.42, **105** (1), 30.—Bringing in 8500–11,500-ft. wells without the need for swabbing, and in an average total elapsed time of only 3–4 hrs. after the removal of the drilling mud to flowing of clean oil into tanks, is fast becoming an accepted method of completing wells by several companies operating in the San Joaquin Valley area of California.

The completion method or technique is essentially one wherein live oil and gas from a nearby, already completed high-pressure well is turned into a new well. The oil and gas displaces and lightens the fluid column in the hole to such an extent that the well will kick over and begin flowing. Final operations prior to completing the well are carried on in the usual manner. The liner is hung, tubing is run in, and the Christmas tree is set in place over the well. A line is then connected between the well-tubing and the mud-pumps.

The pumps are started, pumping water down the tubing and forcing the drilling mud out through the casing outlet. This operation serves the dual purpose of relieving the formation of the heavier weight of the mud column, and at the same time salvaging the hole full of specially treated mud which can be used on the next well to be drilled. The hole is washed until the returns are clear water.

At this point oil and gas, which had previously been piped over from a nearby high-pressure well, is run in with the water being pumped down the tubing. An initial proportion of 1/3 oil and 2/3 water has usually been found to yield the best results. If there is sufficient differential in pressure in the injection well, the oil is fed into the line downstream from the pumps forcing water into the tubing. Otherwise it is mixed in with the water and forced on down the well together. Care must, however, be taken not to put in too much gas and oil at the start, lest the pumps become gas locked. As the pressure on the formation is decreased due to replacing the mud by oil, the well kicks over after a comparatively short cleaning time. A. H. N.

532.* Design of Oil-Field Tank Batteries for Conservation. R. M. Stuntz, Jr., *Oil Wkly*, 30.3.42, **105** (4), 19.—*Paper Presented before American Society of Mechanical Engineers.*—Average evaporation losses from tank batteries are discussed historically beginning with Wiggins' estimate of 6% some 20 years ago for losses from well to refinery. To-day only 1% is lost in the temporary storing of lease production.

Vaporization of a given crude oil depends on the following factors: (1) *Pressure.*—Vaporization is inversely dependent on the pressure maintained in the tanks—that is, the higher the pressure, the less the vaporization. (2) *Surface Exposed for Vaporization.*—Other factors being equal, nearly five times the vaporization would occur in a tank 22 ft. in diameter, as compared with one 10 ft. in diameter. (3) *Temperature.*—Vaporization of a given crude is directly dependent on the tank temperature; the higher the temperature, the greater is the molecular activity and the greater the vaporization. (4) *Agitation.*—Vaporization is increased by agitation. Methods of controlling these factors are briefly discussed. Agitation is usually prevented by one

of four methods: (1) By means of a pipe nipple and an elbow immediately below the oil-inlet opening, the stream of oil is deflected against the shell and permitted to slide down the shell in a wide thin stream. In this way, excess or free gas is allowed to escape and the stream quietly enters the body of the liquid in the tank. (2) By means of a sloping trough the oil is conveyed to the bottom of the tank without agitation. (3) The oil-inlet connection can be placed near the bottom of the tank. This method of entry forces all free gas to bubble up through liquid already in the tank, also causing a considerable amount of agitation. (4) A fourth method consists of a sloping pipe which conveys the oil from the deck to a point about 12 in. from the bottom of the tank. A standard tee is used on the lower end of the pipe to prevent a continued jetting action of the bottom sediment and water in the bottom of the tank. Two 1-in. holes are cut in the pipe immediately below the tank deck. These holes permit gas to leave at this point rather than travel to the bottom of the tank and agitate the oil as it rises.

Closed pressure storage systems are discussed, and aside from evaporation losses it is noted that: (1) There will be a reduction of the hazards attendant to gauging tanks in sour-gas areas. There will be no opportunity for the fatal, or near fatal, accidents which have been caused by breathing toxic vapours. (2) A completely closed pressure system will do much to prevent corrosion of the inner surfaces of metal tanks. There are many examples to be had in which there is no corrosion to be found in the wells, lead lines, or separators, yet the tankage is severely corroded. The tanks are the first place in which the produced fluids are exposed to the atmosphere. If oxygen is excluded from contact with the fluid in the tank, the rate of corrosion should be drastically reduced.

The design of thief hatches and other conservation devices are discussed.

A. H. N.

533.* Air Compressor Station Permits Lifting Economy in Old Field. G. B. Nicholson. *Oil Wkly*, 30.3.42, **105** (4), 25.—The paper describes an efficient and economical system of air-lift which has been working over many years for lifting oil from ageing wells. An examination of the performance of wells operating on air-lift unit shows a record of low lifting costs and negligible maintenance expenses, based on conclusions following a fourteen-year operational period. Despite large quantities of highly corrosive fluid handled, it is recorded that tubing in each well is pulled only twice a year, and then only for inspection purposes to check condition of jets. This efficiency enables the wells to flow at virtually all times, which is important to prevent flooding sands or loading casing with water, followed by a consequent reduction of overall volume of oil produced. Mechanical breakdowns are rare, most of the original equipment is still in use, and repairs have been almost non-existent.

The company concerned realizes a large saving in employing the air-lift method of producing wells in this field. Other types of lift in this area are not entirely satisfactory, due to the volume of fluid which must be handled, and because of quick corrosion caused by salt water. Steady operation of air-lift wells prevents accumulation of water which may otherwise injure the oil-sands, and simultaneously keeps daily production at a maximum. The operators of the air station, with the average air/fluid ratio now about 1400 to 1, calculate that lifting costs of the wells show a sizeable saving compared with those of other wells in the field. Early abandonment of these wells is indefinitely postponed, while both daily and ultimate production are increased.

A. H. N.

534.* Shop-Made Gauging Device Simplifies Salt-Water Handling. G. M. Wilson. *Oil Wkly*, 6.4.42, **105** (5), 15–16.—Inexpensive, simply constructed salt-water gauging units of a type and design that makes their use easily adapted to the production from any single well, group of wells, or an entire lease, are being used with consistently good results by a California oil company. Water, in passing through the unit, is not only accurately metered, but at any time the rate of production may be read from a float indicator on the side of the container, by the pumper, directly in terms of barrels/day production.

The water-gauging is essentially a tall tank provided with an orifice of carefully determined size at the bottom, through which the water escapes. Water entering the tank passes out through the orifice at a rate which is dependent on the height of the

column backed up in the tank. A float inside operates an indicator that moves up and down on a calibrated board on the outside of the tank.

The unit operates on the familiar principle of the orifice-plate meter, widely used on gas-flow lines to measure the volume of gas passing through the system. The operation of the unit and details of its construction are explained. A. H. N.

535.* **Methods for Lifting Oil and Water in Large Volumes.** S. F. Shaw. *Oil Wkly*, 6.4.42, **105** (5), 17.—The reasons for the necessity to lift comparatively large volumes of oil and water from oil-wells are explained. The methods that are employed for lifting oil at a high daily rate are as follows: (1) natural flow; (2) gas-lift in some form; (3) centrifugal pump; (4) hydraulic pump; (5) beam pump. As long as natural flow can be maintained and can lift whatever production is required, it is probable that this method will be employed. Natural flow is the least expensive lifting method that can be employed, since it requires only the opening of a valve to the point where the required production is obtained.

The two forms of gas-lift employed for capacity lifting are straight gas-lift and combination gas-lift. Straight gas-lift is the logical method to follow natural flow, and so far as the well is concerned, if a tubing string has already been run into the well during the work of well completion and while natural flow takes place. It is the simplest and least expensive method to install, since it consists merely of injecting gas through the tubing in sufficient quantity to maintain the desired rate of production. In many cases it is the only method that can be employed that will maintain capacity production, inasmuch as cessation of natural flow takes place at a time when there is considerable gas associated with the oil which interferes seriously with the use of any form of mechanical pump. Straight and combination gas-lift methods are further discussed, in connection with casing sizes and capacities.

In fields of depth of 6000 ft. or more, where the fluid levels are low—that is, where the reservoir pressures are on the order of 10–50 lb./sq. in.—and where there is a large production to be lifted—that is, on the order of perhaps 1000 brls./day, and where casing diameters are no greater than those in use, the straight centrifugal pump has many advantages. If there is but little gas present with the oil, and if sand or caving troubles are not serious, the centrifugal pump can handle this production at rather low cost; but if sand troubles are serious, the expense of pulling the pump and making repairs on the pump and motor may become excessive.

The hydraulic pump possesses considerable capacity, especially where large tubing sizes can be employed. Some difficulty is experienced from the entrance of considerable quantities of sand and also the presence of paraffin in large quantity. However, the lifting expense is lower when using the hydraulic pump than many of the other methods of lifting oil.

The beam-pump is capable of lifting considerable quantities of oil in shallow wells, but becomes reduced in capacity as the wells increase in depth. The casing pump offers a means of reducing the fluid friction that takes place through a small tubing string, especially when pumping from fairly deep wells. Crooked holes are a source of much trouble in wells producing on the beam-pump, especially in wells of considerable depth. A. H. N.

536.* **Pressure Maintenance in the K-M-A Field.** W. H. Rouzer, Jr., *Oil Wkly*, 6.4.42, **105** (5), 22.—*Paper Presented before American Petroleum Institute.*—The K-M-A Pool is an outstanding example of a number of oil operators initiating a programme to conserve a natural resource, and by efficient methods of recovery and gas re-injection ultimately produce millions of barrels of additional oil and save billions of feet of natural gas.

In November 1939 the K-M-A Pressure Maintenance Association was formed to co-ordinate the efforts of over 150 companies operating 375 leases and over $3,000,000 in gasoline plants. A study of the engineering records of these 1591 3800-ft. wells emphasizes the theoretical predictions pertaining to increased gas–oil ratio and declining productivity in a depletion-type reservoir. Gas injection has resulted in lower producing gas–oil ratios and increased productivities.

Results from pressure maintenance in K-M-A have as a rule been quite satisfactory. The ultimate result will be an enormous increase in total oil recovered. But selection

and connection of an input well are but the beginning of the job. The first stages after initial gas injection are the easy stages. Gas–oil ratios will probably decline, due to the assistance given to the natural reservoir moving forces. After a period which, of course, recovers considerable fluid, gas saturation will begin to assert its characteristics by causing high producing ratios. Then again it is the problem of keeping gas production to a minimum so that recovery will be as efficient as possible.

There are frequent complaints of gas channelling. Often, true channelling is confused with coning, a result of too little input gas rather than too much. In either case the remedy is retarded production, which will allow the forces of capilarity, surface tension, and gravity to become effective. The principles of back pressure should always be applied when producing a depletion-type or gas-drive reservoir. Too high a flow-rate or excessive bleeding will result in channelling, whether natural or from gas input, and will cut ultimate recovery to an extremely low figure. It should be remembered that once gas is released from solution in the reservoir, no appreciable amount can be put back. For all practical purposes, it is concluded that no injection gas goes back into solution with the oil. Whether or not pressure maintenance or repressuring is practised or anticipated, all production should be closely watched for unnecessary escape of solution gas. A. H. N.

537.* Water Flooding Efficiency Aided by Laboratory Flooding Tests. R. C. Earlougher. *Oil Wkly*, 13.4.42, **105** (6), 21.—After an examination of several hundred cores from the shallow sand in nearly every part of the Mid-Continent area, together with many cores from the Bradford and Richburg sands of Pennsylvania, it has been found that a relatively close determination of the oil content of the sands can be secured from cores taken with either rotary or cable-tool equipment. Furthermore, probably in 95% of cases the oil content can be secured directly from the core without applying illusory factor in the known ranges of: (1) formation pressure of 0–70 lb./sq. in.; (2) gravity 28–36° API; and (3) permeability from 1 to 350 millidarcys. At this time this statement is limited to these conditions, inasmuch as that is the range covered by the data at hand. It is acknowledged that in some cores there may be a reduction in the oil content of the core because of slight flushing; however, it has been found that for the most part the values obtained from a core are quite reliable in so far as that core is representative of the field.

Detailed description is given of the precautions and methods used to take and test cores so that field conditions are reproduced and data correlatable with actual practice obtained. It is concluded that the use of extensive laboratory flooding tests on core samples, fresh from the field, is proving extremely important as an aid in the interpretation of core data for the purpose of evaluating a stripper property for water-flooding operations. It is a long way from that first method which considered only total oil remaining in place and a recovery factor of 40%; and if applied to its full extent it is ahead of the method which considers mainly the factors of initial oil saturation in place and an intelligent guess at what the final oil saturation should be. Data secured from such tests should reflect two very important results: (1) they indicate the ultimate volume of recoverable oil present in the sand if 100% efficient recovery were to be obtained from the entire sand section; (2) they serve as an extremely useful guide as to what rate of water-flow should be used in order to obtain as nearly as possible 100% recovery efficiency within the economic limit.

In conclusion it is pointed out that other factors, such as range in permeability, also play a vital part in the ultimate oil recovery which can be economically obtained. However, even this factor can be compensated for by certain development and operating methods. A. H. N.

538.* Well Spacing and Lease Allowable Based on Rates of Recovery and Unitized Pressure. P. J. Jones. *Oil Wkly*, 13.4.42, **105** (6), 28.—*Paper Presented before American Petroleum Institute.* If operating reservoir pressures are maintained in the neighbourhood of virgin bubble-point values, such operations recover as much oil as is possible, for the following reasons: (1) the effective viscosity is at its minimum value because gas remains in solution; (2) the effective permeability is at its maximum value because gas cannot evolve and occupy pore-spaces; (3) the displacing efficiency of the driving fluid is not reduced by virtue of shrinkage of the oil not produced; (4) the plugging resulting from deposition and accumulation of paraffin in the neighbour-

hood of well-bores does not occur because the cooling effect of gas expansion is eliminated; (5) the productivity of wells is maintained because the bottle-neck caused by free gas within the first 50–100 ft. of a well is eliminated, and (6) expansion of solution gas is confined to the upper region of fluid columns, where it lightens them and flows wells in some fields to abandonment. The increase in volume of oil produced by such operations may range from 125 up to 200% of the oil otherwise producible—that is, from 1/4 brl. up to 1 brl. more for each barrel otherwise producible. The magnitude of the increase depends primarily on virgin bubble-point pressures and economic limits.

Operating reservoir pressures can be maintained in the neighbourhood of virgin bubble-point values (1) by not letting the rate of volumetric withdrawal exceed the rate of water encroachment, (2) by injecting gas or water at a rate equal to that of volumetric withdrawal on reservoirs having no water encroachment, and (3) by a combination of the two methods.

It is argued that allocation of allowables based on equal opportunites to produce oil is necessary but not sufficient. An incentive in the form of higher allowables for producing oil efficiently is needed. Such an incentive is the relative producing efficiency which stems from, and can be applied readily under, the concept of unitized pressure. It appears that unitized pressure can achieve what is claimed for unitized acreage, without involving the difficulties inherent in the latter. Voluntary unitization of certain acreage and of small tracts would probably be the rule rather than the exception. It is submitted that, if lease allowables were made proportional to rates of recovery and relative producing efficiency, avoidable underground waste, production costs, and steel consumption would be minimized. The discussion is intended primarily for newly discovered reservoirs; however, parts of it may be applied to reservoirs already developed. Inferentially, it is also submitted that if field allowables were made proportional to rates of recovery and producing efficiency, it would, in addition, (1) provide uniform pay-outs as between fields, insofar as it is physically and economically possible to do so by absorbing differences through spacing, (2) provide a reliable method for determining optimum rates of recovery, and (3) provide a scientific basis for pricing crude oil.

The long paper is well illustrated by cost graphs. A. H. N.

539.* Question of Petroleum Reserves. P. T. Moore. *Petrol. Engr*, March 1942, **13** (6), 33–36.—The question involved is formulated as: Is the U.S. at last approaching that time when its oil-drills might not be able to find petroleum as rapidly as it is eaten up by a consumption still increasing?

Pertinent questions involved are those connected with a prolonged war, with the consumer, and with national economy. A long discussion shows that reserves are falling, and a possible solution advocated is "Pay the drill enough," which ended the prolonged period of shortage from 1915 through 1920; a period when gasolineless Sundays in 1918 were due to actual shortage of crude oil instead of transportation bottle-necks, and when, in the summer of 1920, California was rationed for gasoline. By raising prices of crude oil sharply in 1919 and 1920, enough additional drills were finally enticed into discovery work to produce plenty of oil. A. H. N.

540.* Use of Meters for Measuring Production from Individual Wells. W. A. Sawdon. *Petrol. Engr*, March 1942, **13** (6), 60.—Metering in California in particular is studied. Construction and use of piston-type, disc-type, and gravimetric meters are briefly discussed. It is concluded that metering of well production has been done successfully in California and installations have met the demands of both accuracy and economy. Actual percentages of errors vary, and the allowable errors are governed by the purpose of metering. For low-pressure installations, under average conditions, the measurements are frequently kept below 0·5%. Whether metering under conditions adaptable to the use of meters is more nearly accurate than tank gauging is still a question, but, as meters can readily be checked from time to time, there appears to be no reason why they cannot be relied upon.

In high-pressure installations there is still the correction factor to be considered, because of the dissolved and entrained gas being measured with the oil, and an accuracy of from 1 to 1½% is probably as much as can be expected. Yet the economies resulting

from the use of meters on high-pressure production have been found sufficiently great to justify their use. A. H. N.

541.* Gathering System Designed for Gravity Flow in New Michigan Field. J. C. Albright. *Petrol. Engr*, March 1942, **13** (6), 152.—To prevent the unnecessary using up of equipment that might be classified as National Defence materials, and at the same time to lower the cost of operation appreciably, a company recently constructed a gravity-gathering system and an oil pipe-line at Reed City, Michigan. The new field north-west of Reed City compares favourably with many of the larger pools of high flowing potential, the largest gauging approximately 12,000 brls. daily. Instead of producing these wells to capacity, an allowable has been established that permits only 480 brls. of production/day, and drilling is done on a 20-acre spacing, instead of 10 acres or smaller as in other areas.

The major portion of the most productive area of this new field is in Osceola County, in a somewhat hilly country that provides a natural elevation, in some instances approximately 135 ft. higher than the loading rack at the railroad. After the discovery well was completed, which indicted a field of some prominence, the company made an exhaustive survey of the topography, and decided from the results obtained that the oil could be moved from the tank batteries in the field to the loading rack with a minimum of pumping. The trunk and main gathering lines are 6-in. all-welded pipe, and the laterals from the flow-tanks to the main lines range from 3 to 4 in. The operators in the field readily agreed to place their flow-tanks on the highest part of the leases, thus providing as much head as possible for gravity flow in the gathering system so that use of pumping units could be avoided. The system is detailed.

A. H. N.

542.* Petroleum Engineering. Part 3. L. C. Uren. *Petrol. Engr*, March 1942, **13** (6), 156.—This part of the paper describes engineering courses for petroleum students in American colleges. A. H. N.

543.* Pressure Prediction for Oil Reservoirs. W. A. Bruce. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1454, 1–13.—The essentials of a mathematical method of studying the pressure behaviour of an oil reservoir as the fluids are withdrawn are outlined, and methods are noted whereby the behaviour of a reservoir can be used to predict the future relationships between withdrawals and pressure.

The oil reservoir is considered as a small part of a large porous continum which contains water for the most part. The expansion of this water, resulting from a decrease of pressure in the oil zone, causes a movement of water that is an important factor in the relationship between fluid withdrawals and reservoir pressure.

Examples are given to illustrate the methods of pressure prediction for a circular reservoir containing under-saturated crude, the pressure distribution over a field having a uniform production rate, the effect of a fault line near a field, the mutual interference of nearby fields and the disturbing influence of a gas-cap. The analysis is also applied to well-spacing problems. G. D. H.

544.* Completion Practices Related to Well Productivity. W. J. Travers. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1465, 1–8.—Several new procedures for completing oil-wells have been developed in recent years. Each method, when used where properly applicable, promises to be a definite aid to operators in lowering development or operating costs or in developing the full potentialities of the oil-well. Multiple-zone completions are now frequently used in contrast with the older practice of setting a solid water-string over each zone to be produced. Gravel packing in unconsolidated formations often prevents sand troubles formerly experienced where a conventional perforated liner was used. Light-weight bentonitic clay-muds and oil-base drilling fluids are definite steps towards eliminating mudding damage, which occurs when heavy rotary mud is used.

Since in each case the new procedure developed is an alternative to older conventional methods, there is a problem of making a selection. Data are presented concerning the relationship between the initial productivity index and the cumulative production and the effect of drilling-in time on the initial productivity index. In comparisons in one area it appeared that gravel packing and the conventional liner gave similar

results with wells of small potentials, but the former treatment had an adverse effect on wells with high potentials, and the suggestion is made that there will be compensation for this in the form of a flatter decline and more continuous operation, but this is not very well supported by facts. G. D. H.

545.* Productivity Index and Measurable Reservoir Characteristics. J. A. Lewis, W. L. Horner, and M. Stekoll. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1467, 1–9.—Observation and theoretical considerations show that the productivity index is proportional to the average permeability and exposed thickness of the producing formation, and inversely proportional to the viscosity of the oil under reservoir conditions and to the formation volume of the oil. The applicable permeability factor must include the effect of connate water on the permeability to oil and allowance for the presence of gas.

The measured and calculated productivity indices are compared in a number of cases, with general good agreement. The methods are applied to the potentials of pumping wells and also to secondary recovery to predict the water intake, with seeming success in both instances. G. D. H.

548.* Soviet Oil in Relation to Military Campaign. Anon. *World Petrol.*, Dec. 1941, **12** (13), 30.—Some years ago Gubkin estimated the Soviet oil reserves at 20,000,000,000 brl., 9,659,000,000 brl. at Baku, 1,006,000,000 brl. at Grozni, 598,000,000 brl. in the Maikop–Kuban area and 9,477,000,000 brl. east of the Urals. Later Gubkin doubled his total reserve figure, and independent experts have put the figure at least 11,700,000,000 brl. of known reserves, some 16% of the world's total known reserves. The Soviet production has risen since 1932, and reached 222,600,000 brl. in 1940. The rise was about 42%. 86% of the oil production is from the Caucasian region, 72% being from the Baku area. The Maikop–Kuban fields yield 7·5%, and are rising in importance, while the Grozni fields seem to be declining.

The Ural–Volga fields provide about 8% of the Soviet oil, and the Emba fields give 2%.

The refineries fall into four main groups, but only 1·78% of the capacity is in enemy hands, with a further 19·35% in imminent danger. The Ural region has a refining capacity of 83,200 brl./day, or 7·98% of the total capacity.

About 13,000,000 tons of oil/year are moved by tank-cars, 11,000,000 tons by canal and river, and 6,000,000 tons by pipe-lines.

In the Baku area there are 7500–8000 wells, with thirty producing sands. Few of the wells flow, and most are 2500–3500 ft. deep, although a few are 8000–10,000 ft. deep. Grozni has 3200 wells, with the present production from depths of 5000–6000 ft. The Maikop–Kuban wells are mainly 1500–2500 ft. deep.

In the Emba region there are at least 200 salt domes. 400–500 wells have been drilled in the Ural–Volga area, where it has been estimated that on a 10-acre spacing at least 10,000 wells can be drilled. G. D. H.

547. Patents on Production. J. H. Reynolds. U.S.P. 2,274,740, 3.3.42. Appl. 1.12.37. Working barrel support in a well-casing.

H. H. Raulerson. U.S.P. 2,274,937, 3.3.42. Appl. 19.12.39. Resilient counterbalancing device for an oscillating beam.

T. E. Bryan. U.S.P. 2,275,345, 3.3.42. Appl. 21.2.38. Removable gas-lift apparatus in oil-wells.

T. E. Bryan. U.S.P. 2,275,346, 3.3.42. Appl. 9.2.39. Gas-lift valve and surface-operating mechanism.

T. S. Harris. U.S.P. 2,275,364, 3.3.42. Appl. 29.5.39. Deep-well and cistern automatic pumping plant.

A. Boynton. U.S.P. 2,275,416, 10.3.42. Appl. 28.11.38. Bellows-type slugging foot valve for wells.

A. Boynton. U.S.P. 2,275,417, 10.3.42. Appl. 28.11.38. Foot-valve for wells to control the periodic discharge of slugs of liquid.

E. H. Lamberger and B. F. Langer. U.S.P. 2,275,532, 10.3.42. Appl. 18.4.39. Oil-well strain gauge for use in pumping equipment.

M. W. Hartmann. U.S.P. 2,275,627, 10.3.42. Appl. 3.4.39. Pumping system using a centrifugal pump.

A. E. Wright. U.S.P. 2,275,668, 10.3.42. Appl. 19.2.40. Pipe-cleaning device.

T. G. Myers and F. Mason. U.S.P. 2,275,679, 10.3.42. Appl. 27.2.32. Submersible pump and electric motor.

T. G. Myers. U.S.P. 2,275,680, 10.3.42. Appl. 2.5.38. Sealing device to be used submerged in well liquid.

E. W. Patterson. U.S.P. 2,275,919, 10.3.42. Appl. 27.11.40. Crank balanced unit in combination with a speed reduction unit.

R. C. Baker. U.S.P. 2,275,935, 10.3.42. Appl. 6.5.40. Well-packer apparatus.

R. C. Baker. U.S.P. 2,275,936, 10.3.42. Appl. 2.7.40. Casing bridging device.

J. M. Courtney. U.S.P. 2,275,947, 10.3.42. Appl. 27.5.41. Gas-lift pumping device for wells.

S. S. Smith. U.S.P. 2,275,109, 10.3.42. Appl. 1.3.41. Pipe-line cleaner for interna cleaning.

C. C. Cole. U.S.P. 2,276,161, 10.3.42. Appl. 5.7.40. Gun-type casing perforator with a special projectile.

H. W. Cardwell. U.S.P. 2,276,224, 10.3.42. Appl. 24.2.39. Well-servicing and drilling machine on a truck.

R. O. Joslyn. U.S.P. 2,276,401, 17.3.42. Appl. 18.3.40. Well-cleaning apparatus using a tubing and screen.

L. C. Miller. U.S.P. 2,276,544, 17.3.42. Appl. 6.2.39. Perforating device using explosive charges.

G. Kennedy and C. C. Cole. U.S.P. 2,276,783, 17.3.42. Appl. 7.11.38. Fluid-operated motor for deep-well pumping equipment.

S. A. Germain. U.S.P. 2,276,833, 17.3.42. Appl. 6.5.39. Electric heater for oil-wells.

J. W. MacClatchie. U.S.P. 2,277,002, 17.3.42. Appl. 19.8.38. Well-swab, including a tapered mandrel and packing.

D. W. Zuck. U.S.P. 2,277,181. 24.3.42. Appl. 20.9.39. Apparatus for pumping deep-driven wells.

E. E. Coffey. U.S.P. 2,277,306, 24.3.42. Appl. 12.12.40. Deep-well pump.

J. R. Yaucey. U.S.P. 2,277,380, 24.3.42. Appl. 30.11.39. Apparatus for producing wells.

P. S. Graver. U.S.P. 2,277,398, 24.3.42. Appl. 5.10.39. Expansion roof for fluid storage tanks. A. H. N.

Crude Petroleum.

548.* Crude Selection Important in 100-Octane Fuel Production. W. L. Nelson. *Oil Gas J.*, 1.1.42, **40** (34), 14.—The task of rapidly increasing the output of 100 octane fuel from 40,000 to over 150,000 brls. a day is difficult, and it is suggested that consideration should be given to selection of straight-run base stocks of high octane number to supplement more effectively production of blending stocks produced by

alkylation and hydrogenation. A table has been compiled from the literature of naphthenic-base crude oils in the U.S. useful for the production of such straight-run base stocks, showing the field, county, A.P.I. gravity, yield of gasoline of E.P. 400° F., and properties of the gasolines. Crudes from recently discovered fields and those yielding gasoline of high sulphur content are not included. The production of naphthenic-base crude oils fell from 587,000 brls. a day in 1927 to 289,000 brls. a day in 1936. In 1941 and 1942 production will probably not exceed 350,000 brls. a day, but to a large extent the gasoline yield of recent production has been high and the sulphur content low. The new production is mainly from the Gulf Coast area, and one company is already constructing a plant for manufacture of base stock. The production of suitable aviation base stock having an expected octane range of 77–85 probably does not exceed 15,000–20,000 brls. a day. Careful investigation of new production and of naphthenic crude oils at present mixed with others on account of their low gasoline content or small production is advised. Reopening of certain wells shut down in past years for economic reasons may also prove advisable.

R. A. E.

549.* **20% of Texas Oil Labelled Aviation Base.** Anon. *Oil Gas J.*, 15.1.42, **40** (36), 26.—By order of the Railroad Commission, production from sixty-two fields in Texas has been segregated for processing in refineries equipped to produce the maximum amount of aviation-base stock. The allowable production from these fields is approximately 24% of the total for Texas. Names of the fields producing this segregated crude oil, together with production figures and data on gasoline properties and yields, are tabulated. Records of quantities processed and of yields of gasoline obtained must be kept by refineries operating on these crude oils. Methods for increasing the allowable production of these fields and of overcoming the difficulties facing refineries at present treating such oils, but which are not equipped for maximum production of aviation gasoline, are under consideration. R. A. E.

Gas.

550.* **Liquefied Petroleum Gas Use Sets Record During 1941.** G. G. Oberfell. *Oil Gas J.*, 15.1.42, **40** (36), 42.—Although many factors operated against expansion, the sales of liquefied gases increased by 42% as compared with 1940 to a total of 445,000,000 gallons, excluding sales for motor-fuel blends, pipe-line deliveries in the gaseous state to chemical concerns near to the points of supply, and usage by producers. Distribution in millions of gallons to domestic users was 221·9, to gas manufacturers 29·6, and to industrial and miscellaneous users 193·5. Many industrial plants engaged on defence work have installed liquefied gas systems mainly as stand-by to ensure adequate fuel service during high peak-loads on the utility systems. Demand from gas-plants to meet rising peak-loads has also increased, especially in manufacturing centres. In the chemical field, large quantities of special grades of propane, *n*- and *iso*-butane, and butadiene were transported for use in manufacture of nitroparaffins, plastics, and synthetic rubber, and propylene, butylene, *iso*butylene, and other special hydrocarbons are now available in pure and technical grades. The first large-scale installation of propane-fired heaters for removing ice and snow accumulations on switches in railroad yards was laid down during the year. Development of the isomerization process is expected to increase demand for *n*-butane for aviation-fuel manufacture, thus restricting the quantities available for the liquefied-gas industry. R. A. E.

Synthetic Products.

551.* **$400,000,000 Rubber Programme Presents Problems to Refiners.** W. L. Nelson. *Oil Gas J.*, 15.1.42, **40** (36), 19.—The projected increase in manufacture of synthetic rubber will increase the quantities of butane and other hydrocarbons which the petroleum industry will be required to supply. The extent of this increased requirement will depend on the quantities of the various types of rubber-like materials needed to give a balanced output, but may amount to 20,000–30,000 brls. of butane fractions

per day. Including requirements for production of 100-octane gasoline, the demand is expected to range from 43,000 to 80,000 brls. a day. It is estimated that at present one-third to one-half of recoverable butanes are not removed in natural gasoline plants and refinery gas-recovery systems. More complete removal of these fractions would probably enable requirements to be met for some time to come, and would involve only small additions to equipment at recovery plants. R. A. E.

552.* Petroleum is Plentiful Source of Raw Materials for Chemicals. L. F. Hatch. *Oil Gas J.*, 29.1.42, **40** (38), 197.—The history of the synthetic production of chemicals from raw materials provided by the petroleum industry since 1922, when *iso*propyl alcohol was first produced commercially from propylene, is briefly outlined. The trend towards segregation of individual hydrocarbons from petroleum will tend to enlarge the field. Particular consideration is given to the production of glycerol from propylene, the manufacture of nitroparaffins, ammonia, and alcohols, and to the possibilities opened up in chemical manufacture not only from these materials, but also from the bye-products produced during their manufacture. R. A. E.

553.* Sufficient Butane can be Made Available for Synthetic Rubber. W. L. Nelson. *Oil Gas J.*, 29.1.42, **40** (38), 199.—The properties of some of the more important synthetic rubbers are compared with those of natural rubber, with particular reference to strength, elongation, chemical stability, and wear resistance.

Generally the synthetic products are superior to the natural product in respect of resistance to attack by chemicals and solvents, and resistance to oxidation, with consequent hardening and cracking, this superiority being most marked in the cases of butyl rubber and vistanex. The utilization of the synthetics will be selective, and dependent on their properties. As far as can be seen at present, it is considered that butyl and Buna S will be two of the most important types, so that the bulk will probably be made from butadiene, styrene, and butenes. There is probably an adequate supply of styrene available for Buna S requirements in the xylene fraction of coal-tar; if not it can be supplemeted by manufacture from benzol and ethylene. Butanes from petroleum will probably prove the cheapest source for obtaining the required supplies of butenes and butadienes. The quantity of butadiene needed will probably range from 3000 to 8000 brls. a day. Yields obtainable from thermal or catalytic cracking processes are low, but by modification of operating conditions of plants manufacturing *iso*butene from *iso*butane for high-octane gasoline production, it may be possible to obtain a by-product from which the required quantity of butadiene can be separated, for example, by solution in cupric chloride. Should these methods prove inadequate, further supplies could be obtained by dehydrogenation of butane at 1100–1200° F. in the presence of chromium oxide catalyst supported on alumina, yielding 60–75% of butenes on recycling. By long-continued heating or repeating the operation on butenes, yields of 60–80% of butadiene are obtained, giving an overall yield of 36–60% butadiene from butane. If butyl rubber is made, a suitable feedstock mixture might be obtained in a single dehydrogenation operation, as separation of pure butadiene and *iso*butene may be unnecessary. R. A. E.

554.* Preparation of Methyl Chloride from Natural Gas. Anon. *Oil Gas J.*, 12.2.42, **40** (40), 33 (translation from "Zhurnal Prikladnoi Khimii," Vol. 12, No. 12).—For these experiments natural gases from the Baku area, having a methane content of 99·7–99·8% by vol. and commercial chlorine, were used. Natural gas and chlorine, after passing through acid and calcium chloride, are mixed and delivered to a reaction vessel in an electrically heated furnace, the heated portion being filled with catalyst. The products are passed through ice-cooled water (to remove HCl), calcium chloride, and finally to a petroleum-ether bath cooled to — 130 to — 140° C. Distillation in a Podbielniak apparatus was found to provide the best method of analysis of the reaction products, and means employed for determining methyl chloride yield on consumed methane and chlorine are described. Experiments were carried out to determine effect on yield of methyl chloride of temperature of chlorination, rates of gas-flow, ratio of chlorine to methane, varying catalyst, and finally composition of natural gas used. The principal conclusions arrived at are: (1) With suitable catalysts and at reaction temperatures of 350–500° C. 80–85% of chlorine passed and of reacted methane are

consumed in the formation of methyl chloride, and 80–86% of the condensate consists of chemically pure methyl chloride, boiling within the range −25 to −23° C.; (2) of the catalysts investigated, cupric chloride on pumice, cupric chloride promoted by cerium chloride, iron shavings, and aluminium shavings were the most effective; at 450° C. and a ratio methane to chlorine of about 10 : 1 by vol. the condensate may contain 87% of methyl chloride; (3) variation of contact time between 0·5 and 40 sec. has little effect on methyl chloride yield or concentration; (4) a ratio of methane to chlorine of about 10 : 1 by vol. yields best results—on lowering the ratio the amount of polysubstituted derivatives of methane increases; (5) under established conditions of highest yield of methyl chloride, the residue gas is pure methane, which may be recirculated; (6) using a natural gas containing 91·3% methane, 4·2% ethane and higher, 4·5% air, and CO_2 as base material, it was found that the yield of methyl chloride calculated on the total volume of chlorine derivatives decreased appreciably when using a cupric chloride catalyst, and also that higher hydrocarbons are condensed simultaneously with methyl chloride, thus introducing separation difficulties. With iron shavings as catalyst, the yield of methyl chloride was even lower, and catalyst poisoning soon occurred. It is therefore recommended that higher hydrocarbons, if present, should be removed from natural gases before processing. R. A. E.

555. Natural Gas as a Raw Material in the Production of Synthetic Ammonia. F. H. Dotterwiech. *Refiner*, March 1942, **21** (3), 63–67.—Synthetic ammonia production in the Axis-dominated countries is estimated at 2,775,000 tons, leaving but 1,135,000 tons of capacity for the rest of the world. The 1940 peace-time output of the United States is estimated at 260,000 tons, with total defence needs estimated at 550,000 tons.

At the present time, of the gases used in this synthesis, the most expensive and difficult to obtain is hydrogen. Hydrogen may be separated from coke-oven gas, obtained as a by-product in certain cracking processes, in the alkali-chlorine industry and certain fermentation processes, or quite pure as electrolyte hydrogen should cheap current be available. Three-fourths of the synthetic ammonia production is now made by the water-gas reaction, using coke or anthracite coal as raw material, this process yielding both the hydrogen and nitrogen required.

It is believed that although there are but few plants operating in the U.S.A. and Canada using natural gas as a source of hydrogen for this process, the future should bring a great number of them. The paper briefly reviews the water-gas process, the steam-conversion process, and products from synthetic ammonia relating to explosives, The chemistry and thermodynamics of processes are also obtained. A. H. N.

556. Synthetic Rubber. J. V. Hightower. *Refiner*, March 1942, **21** (3), 68–70.—It appears that at the present the programme for manufacturing synthetic rubbers is concentrated on producing Buna rubber. By concentrating on Buna production, the use of large quantities of chlorine, used in some other types of synthetics, could be avoided. Furthermore, the supply of the hydrocarbons used largely in the Buna rubbers is potentially great. A third consideration is that at least one variety of Buna rubbers has satisfactory qualities for tyre and tube production, which has been consuming 70% of the rubber supplies.

The Buna rubbers, notably Buna S and Buna N, consist largely of butadiene polymerized with (1) styrene in the case of Buna S and (2) acrylonitrile in the case of Buna N. These rubbers are vulcanizable. Buna S is reported well suited to tyre manufacture, more so than Buna N, although extensive road tests have been made with both types. High resistance to destructive action by gasoline, oils, and many organic solvents qualify Buna N for numerous speciality services.

Butyl rubber, like the Bunas, is basically composed of hydrocarbon gases obtainable in the oil industry. This is a product resulting from the polymerization of butylenes or other olefin gases with small amounts of butadiene. The product has the advantage of being made from olefins which are produced in greater volume in refineries than butadiene, but was recently declared as not yet developed as well as Buna as a material for tyres. This rubber is quite stable, chemically speaking, resistant to the passage of gases, is vulcanizable, and adapted to speciality uses, although is not resistant to the action of naphthas. Neoprene, a synthetic which last year led the others in production, utilizes acetylene gas as a raw material. The gas is polymerized to monovinylacetylene, which is treated with hydrochloric acid to produce chloroprene. In

turn, chloroprene is polymerized to form the synthetic rubber. It has been widely tested in tyres and the manufacture of specialty products. Neoprene is rated high in resistance to abrasion and to chemical action.

The questions of obtaining butadiene, and even styrene, from petroleum in sufficient quantities, of the equipment needed, and certain economical considerations are discussed. It is noted that even if with large-scale production it developed that the cost of synthetic rubbers remained higher than natural rubber, the fact that the synthetic products as a class have many qualities superior to those of natural rubber, including resistance to abrasion and sunlight, will favour such products and offset any price differential that may ultimately remain. A. H. N.

Refining and Refinery Plant.

557.* Psychrometry of Cooling Towers. E. Simons. *Chem. Met. Eng.*, April 1942, **49** (4), 82–86.—The paper is a review of some of the basic principles of psychrometry and a projection of the principles into the field of cooling-tower design and operation.

Using gas laws, principles of heat exchange, and of molecular diffusion, formulae are derived, and are given in conjunction with other data. A. H. N.

558.* Bender Lead Sulphide Treating Process Proves Economical. Le R. Eaby. *Oil Gas J.*, 1942, **40**, 37, 25.—The normal doctor treatment converts mercaptan sulphur into the less objectionable disulphide form. The reaction is usually explained on the following lines:

$$2RSH + Na_2PbO_2 \longrightarrow Pb(SR)_2 + NaOH$$
$$Pb(SR)_2 + S \longrightarrow RSSR + PbS$$

It is found in practice, however, that the quantity of mercaptan converted into disulphide per unit weight of plumbite is greater than can be accounted for on these grounds. Various investigations point to the conclusion that the PbS formed during the main reaction catalyses certain side reactions. Use has been made of the reaction:

$$2RSH + O_2 \xrightarrow{(PbS)} RSSR + H_2O$$

The Bender system is designed to take maximum advantage of the reaction:

$$2RSH + S \xrightarrow{(PbS)} RSSR + H_2S$$

Sufficient aqueous NaOH is added to remove excess H_2S.

The main advantages claimed for the process are: (*a*) low running costs, (*b*) low stock losses, (*c*) chemicals used are relatively harmless and non-corrosive, (*d*) the system permits a compact lay-out and results in space-saving, (*e*) equipment required is simple, (*f*) operation is flexible and easy, (*g*) the process is applicable to any refinery product which requires mercaptan conversion.

Details of the preparation of a suitable catalyst are included. The article is illustrated with diagram and photographs of the units in service at the Sinclair plant in Marcus Hook, operational statistics of which are also shown. C. G. G.

559. Fundamentals of Refinery Piping Design. Part II. A. Cibulka. *Refiner*, February 1942, **21** (2), 45–47.—The paper deals with the design of anchors and supports. For an overhead line the tie-rods anchored to the base of the pipe support themselves or to special deadmen provide an inexpensive anchorage.

For underground lines or lines close to the ground a concrete block is used for the purpose. The friction between concrete and the earth in the ultimate analysis is the only dependable factor for the transmission of forces, and therefore the friction surface should be made as large as possible. Short post-holes filled with concrete, reinforced with some scrap-rods, form a very effective, cheap friction pile.

For pipe support, structural steel sections, special thin-walled, pressed-steel sections, secondhand or new pipes, concrete or wooden poles may be used. Contrary to popular belief, wooden columns are far more fire-resistant than the unprotected steel sections, especially those made of thin pressed plates. Wooden columns will char on the surface, but do not lose strength, and will last for hours, where steel may collapse within a few minutes. Creosoted poles are cheaper, and do not require painting and protective

concrete foundations. They are easily installed, moved around, recovered, and are strong enough for any loads usually encountered in the practice. In dangerous locations the wooden top beams can be made reasonably fire resistant by thin sheets of galvanized iron nailed directly to them.

Charts are given for calculating the sag in pipes. The pitch of pipe-lines is usually expressed as so many inches in a certain number of feet. This expression is called the "average gradient" of the pipe-line. The formula given below indicates the maximum length of unsupported piping which can be permitted without allowing the deflection of each span to exceed the drop in elevation :

$$\text{Average Gradient} = \frac{144S^2y}{36S^2 - y^2}$$

where S = length of one span in feet, y = deflection of one span in inches.

A. H. N.

560. Fundamentals of Refinery Piping Design. Part III. A. Cibulka. *Refiner*, March 1942, **21** (3), 84–94.—This part of the paper deals with the dimensions and strengths of piping, and for the convenience of designers and detailers the scattered information most frequently needed has been concentrated in a few pages. Tabulations and figures give more than fifty separate and useful items for steel pipe from ⅛ in. to 16 in. in diameter. Detailed dimensions for piping layouts, areas of metal, moments of inertia, radii of gyration for structural designers, volumes and surfaces for hydraulics or heat exchange problems—all essential information can be read directly from the table.

For sizes larger than 16 in. in diameter, not often encountered in practice, the catalogues must be consulted until some manufacturer compiles a continuation of these tables.

Details for brass, copper, lead, and transite pipe dimensions and specifications are given. Critical external pressures for pipe or cylindrical shells from 12 to 168 in. in diameter are also given. Internal pressures are also given in a separate figure. At temperatures higher than 800° F. the metal subjected to stress begins to flow or creep. It elongates permanently, and will not spring back to its original length when the load is removed, as is the case with the elongation produced within the elastic limit.

After a certain time this elongation due to the creep reaches an unsafe limit, and the tubes must be taken out of service. But the stress and time elements are not directly proportional. Doubling the stress may shorten the time factor by ten to thirty times ; therefore the safe creep stress should be determined by experiments on the material in question, duplicating as nearly as possible the working conditions expected in the actual service. Time is a very important factor in design based on creep. There is no advantage in designing an apparatus for 100,000 hr. (11 years) creep stress when the economical life expected is only 1 or 2 years. 1–3% elongation is used by engineers as safe limits for creep, depending on the importance and dangers of the process. Figures give creep properties of some metals frequently used in refining processes.

A. H. N.

561. Fundamentals of Refinery Piping Design. Part IV. A. Cibulka. *Refiner*, April 1942, **21** (4), 123–124.—Flow problems for refining plants are studied. Selection of the proper pipe size is an engineering as well as economical problem. The pipe serves a certain purpose, and should do so properly. A steam-line must deliver so many pounds of steam/hr., at a certain pressure and a certain temperature (superheat), to a turbine or to a pump. Otherwise, if all the conditions are not met, the operation will suffer. Correct size and good insulation are essential. Water, oil, steam, air, vapour lines, all carry fluids. Flow causes friction, pressure drops, loss of energy, which must be paid for. Pumping cost has to be taken into account. These factors are briefly discussed.

A. H. N.

562. Heat Exchanger Tube Sheet Temperatures. K. A. Gardner. *Refiner*, March 1942, **21** (3), 71–77.—Since the permissible stress intensity of non-ferrous metals decreases rapidly with increasing temperatures, considerable valuable material may

be wasted by unduly cautious estimates of metal temperatures in heat-exchanger tube-sheets for design purposes. To provide a sound basis for reasonably accurate estimates, the author presents equations for calculating the metal temperatures in the unpierced and pierced portions of tube-sheets. The derivation for the latter case is given in some detail. Examples of the use of these equations are given, using as a basis the expression $f_{max.} = PR^2/L^2$; it is suggested that, if this expression is approximately correct, it is reasonable to assume that this maximum stress intensity occurs in the pierced portion of the tube-sheet.

The assumptions made in deriving the equations are: (1) The tube-sheet ligament between adjacent tubes is thin enough, compared to its length, to result in a negligible temperature gradient over any cross-section normal to its length. (2) The thermal conductivities of the tube wall and tube-sheet metals are the same. (3) The heat-transfer coefficient at the tube side-face of the tube-sheet is the same as the coefficient through the tubes. (4) The area through which heat flows at the shell side of the tube-sheet includes the cross-sectional area of the tube walls.

After discussing the examples in detail, a rule for approximation is derived. Since one example was deliberately chosen to give the largest difference to be expected in practice between the maximum metal temperature and the tube-fluid in a water-cooled exchanger, it may be used as the basis for a rough rule of thumb, which may be stated as follows: The maximum metal temperature in the pierced portion of the tube-sheet of a water-cooled exchanger will not exceed the sum of the tube side design temperature plus 15% of the difference between the two design temperatures.

A. H. N.

563. Butadiene Calls for Few Departures in Equipment or Processing. J. V. Hightower. *Refiner*, April 1942, **21** (4), 101.—Equipment for the preparation of feed-stock for a butadiene unit largely consists of fractionators, and such equipment may already be available. Some natural-gasoline plants are fractionating butane cuts which are probably capable of being used as feed-stocks without further fractionation; the same is true of numerous refining units which are fractionating butane cuts from either crude or refinery gases. Fractionation is also required to produce liquid feed-stocks if these, rather than butanes, are to be converted into butadiene. In either case the equipment consists of conventional fractionator towers and such subsidiary equipment as charge-pumps, reflux pumps, drums, heat-exchangers and perhaps absorbers and compressors.

In the butadiene plant proper, the first processing step consists of cracking the feed-stock, or heating it (if a catalytic process is used) to the temperature where catalytic conversion of the material into butadiene will occur. The pressure involved is low, being, it is understood, around 150 lb./sq. in., or lower. A high temperature, ranging between 1000° and 1300° F., is necessary. Furnace coils of alloy steels are required at points where these high temperatures are encountered, although carbon steel might be used in the cooler sections of the furnace. Valves, instrument connections, and other fittings subjected to the high temperatures would also be of alloy steel. The furnace box would require such familiar equipment as oil- or gas-burners, refractories and tube hangers.

Low temperatures of −60° F. are involved in certain parts, and for these special alloy steels are used in valves, etc. Otherwise the equipment is conventional.

A. H. N.

564. Mercaptans Removed Prior to Doctor Treating. Anon. *Refiner*, April 1942, **21** (4), 103–106.—Gasoline treatment in the plant described is accomplished in three successive stages: a precaustic wash for the removal of hydrogen sulphide, caustic scrubbing for reduction of mercaptan content, and doctor-sweetening to a finished product. The three are phases of a continuous system whereby a blend of cracked distillate and plant-recovery vapours moves in uninterrupted flow through the three treating phases. The plant and its operation, together with the regeneration of caustic and disposal of mercaptans, are described in some length. Savings effected by the plant are discussed.

Important features of this system, which allows of economical sweetening of full-range Mid-Continent cracked gasoline with available chemicals, and without lowering of the TEL response, may be outlined as follows: (1) main hydrogen sulphide removal

by debutanization; (2) low Be. caustic soda prewash for partial acid-oil removal; (3) 80% mercaptain removal through packed tower regenerative caustic system; (4) temperature- and time-controlled doctor and sulphur contact; (5) meter-controlled and recorded sulphur addition, checked against butyl mercaptan and other tests; (6) continuous doctor treatment with carefully adjusted alkalinity, sodium plumbite, and lead sulphide conditions in gum-free treating solution.

A summary of the operating procedure shows that it is essential to keep the caustic well regenerated, to keep air from entering the system along with the caustic, and to maintain an even, unbroken flow of gasoline to the scrubber. The gravity of the caustic should not fluctuate, and the concentration of the phenols in the mercaptan-scrubbing caustic should be controlled by charging fresh caustic to the system as frequently as tests determine that this should be done. A. H. N.

565. Conditioning Raw Natural Gasoline in the Field. Anon. *Refiner*, April 1942, **21** (4), 112–114.—A description is given of a plant used by one company to provide a source of isobutane.

Details are given of fractionators and similar equipment in the plant. A. H. N.

566. Making the Refinery Weld. W. L. Archer, *Refiner*, April 1942, **21** (4), 119–121.—The fundamentals of good welding practice for refinery purposes are discussed. A. H. N.

Fire Prevention.

567.* Control of Oil Fires. A. F. Dabell. *Petrol. Times*, 2.5.42, **46** (1168), 207.—The principles involved in an oil-fire are briefly outlined. It is felt that the fire precautions for oil-storage installations which have proved efficient in the past cannot be deemed capable of coping with the present-day hazards of unusual and unforeseen nature, in particular those arising from the destruction of pipe-lines. Action must, therefore, at times be restricted to precautionary control of fire, rather than its immediate extinction.

It is suggested that by collection and disposal of burning gas and the provision of natural drainage, the liquid can be collected at distant points, with risk to life reduced and maximum salvage obtainable.

The author feels that in the case of large installations, the modern practice of eliminating auxiliary pumps and of concentrating plant calls for revision, and recommends that increased facilities for the release of vapours from oil tanks now be provided.

Storage tanks, pipe-lines, and oil in rivers and canals are discussed separately. Water is, contrary to public opinion, the most valuable asset for oil-fire fighting; but other agents are also discussed—*e.g.*, foam. The paper is then summarized under general and special conclusions. A. H. N.

Analysis and Testing.

568. Note on Temperature Correction Methods in Calorimetry. R. S. Jessup. *J. Appl. Phys.*, February 1942, **13** (2), 128–137.—The problem of correcting calorimetric data for thermal leakage has been discussed by King and Grover in a recent paper in the *Journal of Applied Physics*. From their analysis of the problem these authors have concluded that large errors are involved in the usual methods of correcting the data of bomb-calorimetric measurements, and of experiments by the method of mixtures. In the present note it is shown, in agreement with W. P. White's treatment of calorimetric lag, that in the case of bomb-calorimetric measurements the errors in question are practically completely eliminated by calibrating the calorimeter experimentally. Since experimental calibration of the calorimeter is the usual practice in modern bomb-calorimetric measurements, the results of such measurements are not affected by the errors discussed by King and Grover. In case of measurements by the method of mixtures, these errors can be avoided by so conducting the experiment that the final temperature of the calorimeter will be very near the convergence temperature. A. H. N.

569.* Application of Spectroscopy in the Petroleum Industry. J. R. Nielsen. *Oil Gas J.*, 1942, **40**, 37, 34.—A lecture review of published work on emission, absorption and Raman spectroscopy as applied to hydrocarbons and other products of interest to the petroleum industry. Illustrated with tables and diagrams. 13 references.
C. G. G.

570.* Convenient Graphical Method for the Valuation of Lubricating Oil Crudes. H. Moore, *Petrol. Times*, 1942, **46**, 1162, 68.—The valuation of a crude oil which is to be worked up for lubricating oils is frequently carried out by fractional distillation in vacuo, a number of narrow cuts being separated. The viscosity of each fraction is determined, and the composition of the oils which will ultimately be produced in the refinery is found by experimental blending of these cuts to the predetermined viscosity figures.

This procedure can be simplified by isolating a few narrow cuts during the distillation, and plotting their absolute viscosities on a log. scale against their mean composition, expressed as the percentage range of the lube-oil residue. The curve is then drawn. In the portion corresponding to the lower viscosities the graph is nearly straight and shows average composition for a given viscosity. In the higher portions some allowance must be made for slight curvature.

By choosing suitable scales, other characteristics, such as flash point, sp. gr., cold test, and coke test, may be plotted on useful blending diagrams. The article is illustrated with diagrams of the type discussed, and examples of their uses are given.
C. G. G.

571. Investigation of the Aromatic Portion of Light Oil Fractions. E. A. Robinson. *Zhurnal Prikladnoi Khimii*, **13** (12), 1852–1868. Translated by J. G. Tolpin. *Refiner*, March 1942, **21** (3), 78–83.—Since the differences between the properties of aromatics and other classes of hydrocarbons are not very pronounced in the higher-boiling oil fractions, no reliable methods of determining them in lubricating oils are available. The methods proposed for this purpose, including the use of selective solvents, hydrogenation of aromatics to naphthenes, and treatment with sulphuric acid, were evaluated in an experimental study under consideration of the available literature material. In the case of the lubricating fractions of two oils, a paraffin-base and a naphthene-base oil, it was shown that the types of aromatic compounds can be determined with a reasonable degree of probability by removing the aromatics from the oil, adding known aromatics, and comparing the properties of the obtained mixtures with those of the original oil fractions. On the average, the same type of aromatic compounds were found to be present in both oils.

Notwithstanding literature references that paraffin-base oils contain aromatics with long paraffin chains, these two oils were found to contain no compounds of this type of the composition $C_{16}H_{33}$ or $C_{18}H_{37}$ in the fraction boiling at 160–200° C. and 1 mm. pressure, although one of them (Karachukkur oil) was found to contain from 12 to 14% aromatics, and the other (Balakhany oil) 30–32% aromatics. The average composition of the aromatics in the fraction boiling at 130–160° C. and 1 mm. pressure corresponds either to dicyclic aromatics with an aliphatic chain, or monocyclic aromatics containing naphthene rings in the side-chain. The conclusions reached for the fraction boiling at 190–220° C. and 1 mm. indicate the probable presence in it of either tricyclic aromatics with a paraffin chain, or of dicyclic aromatics with a paraffin side-chain, containing one or two naphthenic rings, the total number of rings in the molecule being not less than three.

Considering the constants of the hydrocarbons isolated by Rossini from Mid-Continent oil, the composition of the fraction 205–210° C. and 0·5–1·0 mm. of the two oils are also thought to be subject to the above conclusions concerning the type of aromatics present in them. Published data for other oils of different types are held to point to a similar composition.

All data given in the original are included in the translated article. A. H. N.

Chemistry and Physics.

572. Some Applications of the Kinetic Theory to the Behaviour of Long Chain Compounds. H. Mark. *J. Appl. Phys.*, January 1942, **12** (1), 41–45.—If long-chain

molecules pass from the extended into the contracted state, a certain amount of curling energy and curling entropy may be developed. In recent years several authors have discussed these energy and entropy changes in connection with the elastic properties of long-chain high polymers. In this paper the melting points of long-chain compounds, their swelling tendencies, and their viscosities in dilute solutions are discussed mathematically. A. H. N.

573. Structure and Dynamics of Liquids. W. E. Roseveare, R. E. Powell and H. Eyring. *J. Appl. Phys.*, September 1941, **12** (9), 669–679.—By co-ordinating information on viscosity, diffusion, melting, and other rate and thermodynamic properties, a detailed picture of liquid structure is built up. Thus it is found that a liquid is best thought of as a solid, to which a large number of empty equilibrium positions are added. In fact, the expansion on melting, as well as the expansion with a rise in temperature, arises almost entirely from this introduction of new equilibrium positions, and only to a minor extent from lattice expansion. Information is then obtained as to the number, size, and energy of formation of these empty lattice points. A. H. N.

574. Correlation Between Elastic Moduli and Viscosity of Liquids and Plastics. A. Gemant. *J. Appl. Phys.*, September 1941, **12** (9), 680–685.—The chief purpose of this presentation is a practical one. The correlation appears to be valid also for plastic materials or for a series of materials ranging from the liquid to the plastic state. It is often required to know viscosity values of plastics where direct measurements are difficult or even impossible, yet the measurement of an elastic modulus is easy. On the other hand, it is often required to know the velocity of propagation of acoustical waves (*i.e.*, compressibility) of liquids for which viscosity measurements can be carried out much more easily and quickly.

By means of a simple theory, an equation, establishing a connection between elastic moduli of liquids and plastics and their viscosity, is derived. The equation, which contains two constants only, can be used either for a given substance in a range of varying temperature and pressure, or for a series of chemically related materials. The usefulness of the equation is shown on simple hydrocarbons, petroleum fractions, plasticized polyvinyl chlorides, and glasses. A. H. N.

575. Frictional Phenomena. Part II. A. Gemant, *J. Appl. Phys.*, August 1941, **12** (8), 626–633.—On the basis of the kinetic theory, an explanation is given both of the viscous forces within a gas and of those external frictional forces operative between a gas and a wall. The extent to which the theory is able to reproduce the existing experimental data on the viscosity of different gases, and the variation of viscosity with pressure and temperature are shown. A. H. N.

576. Frictional Phenomena. Part III. A. Gemant. *J. Appl. Phys.*, October 1941, **12** (10), 718–724.—The extent to which viscous processes can account for the absorption of freely travelling acoustical waves in gases is shown. Considerable divergence between theory and experimental data is found for polyatomic gases, and an explanation of this divergence on the basis of intramolecular vibrations is presented. A. H. N.

577. Frictional Phenomena. Part V. A. Gemant. *J. Appl. Phys.*, December 1941, **12** (12), 827–836.—This paper presents theories of liquid viscosity, particularly those of van der Waals, Andrade, Prandtl, and Eyring. Whereas the viscosity of gases is based on the collisions of molecules, that of liquids is dominated chiefly by molecular attraction forces. Experimental material is presented on the effect of chemical constitution, temperature, pressure, and mixture ratio on viscosity, which effect is explained on the basis of existing theories. A brief outline of turbulent flow closes the paper. A. H. N.

578. Frictional Phenomena. Part VI. A. Gemant. *J. Appl. Phys.*, February 1942, **13** (2), 90–96.—Colloidal particles present in solutions and suspensions increase the effective viscosity of the solvent. Einstein has presented the theory of this effect valid for spherical particles, and given an equation, deviations between which and experiments being due to either solvation or electric charge of the particles. Elongated

particles require a further modification of the formula. The theory is being successfully applied to the study of synthetic fibre molecules, and valuable information as to the shape of the latter can be derived by viscometric measurements on colloidal solutions of such polymers. A. H. N.

579.* Ultraviolet Light and Gasoline Testing. J. De Ment. *Refiner*, April 1942, **21** (4), 125–126.—References are given to books and previous papers dealing with the subject. Ultra-violet light may be employed for testing the stability of gasoline and for determining gum-forming tendencies. As contrasted to fluorescence work, unfiltered, high-intensity light from a mercury-quartz arc is employed for stability testing. Ultra-violet light gives good results in stability testing, whereas tests with white light have resulted in unsatisfactory evidence. A sample is exposed in crystallizing dishes covered with Cellophane, and then in Pyrex dishes to the radiations from a quartz-mercury arc drawing 5·4 amperes with a 110-volt drop, placed 30 centimetres away from the gasoline surface. The results are decisive, and show a difference in the quality of two gasolines between which bomb tests had failed to exhibit a marked difference. The tests were completed by bomb tests following the exposure to ultra-violet rays. When the gum did not exceed 10 milligrams, reproducible values were obtained, but with greater values the accuracy varied as much as 10%. The experimenters believed optimum conditions to be ultra-violet irradiation for 1 hr. and heating to 100° C. for 3 hr. In ordinary gasoline the case is slightly different for ultra-violet irradiation for 30 mins. and heating for 2 hr. suffices.

Tests for other purposes are described briefly. Special patent literature of interest in cracking oils, removing "bloom", precipitation of objectionable substances, etc., are mentioned. An interesting fact is that a solution of gasoline in alcohol, when placed in a fine capillary tube and exposed to ultra-violet light from a mercury arc, moves appreciably when in a horizontal position. This means that the surface tension of the solution changes and the order of movement is from 1 to 2 millimetres/hr. Other solutions also exhibit this interesting property. A. H. N.

580.* Hydrocarbon Hydrates. I. C. Bechtold. *Refiner*, April 1942, **21** (4), 115–118. *Paper Presented before California Natural Gas Association.*—Historical development of the subject is briefly discussed. The chemical composition of these hydrates is difficult to determine. After a survey of the theories advanced is made, Villard's theorem is quoted: "Dissociable compounds, capable of existing only in the solid state, formed by water with various gases, are isomorphous between themselves, and crystallize in the cubic system, and their composition is expressed by the general formula: $M \cdot 6H_2O$, where M represents one molecule of the gas under consideration."

This viewpoint is in agreement with the conclusions reached by Nikitin, and is consistent with the general aspects of hydrate formation as they would be developed from Werner's co-ordination theory. Although it now appears that there is considerable doubt as to the exact composition of many hydrates of normally gaseous substances, it is assumed for purposes of discussion that all the hydrocarbon hydrates contain six molecules of water. Hydrates of ethane, propane, and the butanes have been reported in the literature, and data have been published to show the conditions necessary for their formation. There is considerable doubt as to whether normal butane forms any hydrate; Hammerschmidt could not produce this hydrate at pressures up to 800 psi. To date, it is definitely true that no hydrates of hydrocarbons heavier than butane have been reported.

The conditions necessary for the formation of hydrates are high pressures, certain limitations to temperature and composition. For a given temperature there must always be no less than the equilibrium pressure in order that hydrate may exist. In connection with composition, it may be added that it is always necessary that the gas be saturated with respect to water vapour at the equilibrium point before hydrate crystals will appear. Although the primary conditions may be proper for hydrate formation, it is not always true that the solid will immediately appear. These gas–water mixtures have a tendency to exist for long periods under measurable conditions. Certain secondary effects play a large part in determining whether these solids will appear under field conditions. For example, high velocities, turbulence, pulsations from compressors, sharp bends and similar conditions, which readily promote a mixing

action, will augment the formation of the solid phase. On the other hand, conditions which result in low velocities and little turbulence may allow gases to exist without the formation of a solid phase, even though the three primary conditions may be in proper relationship for hydrate formation. Once the solid has formed, or has started to form, it will proceed very rapidly under proper conditions because of the "seeding" effect of the crystals which have developed. Hydrate control is studied with these principles in mind. Prevention of hydrate formation is advocated as a better safeguard than methods alleviating its troubles. A. H. N.

Lubricants and Lubrication.

581. Mineral Oils in Hot Tinning. Anon. *Chem. Tr. J.*, 5.12.41, **109**, 282.—Compounded oils have been developed by the Tin Research Institute in collaboration with an oil company, to replace tallow for hot tinning and palm oil for tin-plate making. The oils are specially selected mineral oils containing active agents, and are superior to the glyceride oils generally used for tinning in respect of, *e.g.*, stability at high temperatures over a prolonged period. Their use is likely to lead to an improvement in the technology of the process. Results from large-scale trials by the Institute have been confirmed in industrial plants. C. L. G.

582. Studies in Lubrication. Part X. F. Morgan, M. Muskat and D. W. Reed. *J. Appl. Phys.*, October 1941, **12** (10), 743–752. Studies have been made of the stick-slip behaviour recently investigated by Bowden and collaborators. The friction apparatus consists essentially of a table which can be made to rotate at a very low velocity and a slider elastically supported at the centre of rotation of the moving surface. Examples are shown of the stick-slip process with several combinations of metals at various speeds and loads. Motion pictures of the slider and table have been made in order to study possible slipping during the stick phase. Temperature records of the stick-slip cycle indicate that the temperature flash is confined exclusively to the slip period and in no case studied exceeds 50° C. above ambient. Traces made of the slip phase with very high camera speeds permit an analysis of the variation of kinetic friction with velocity. Thus both static and kinetic friction data can be obtained from a single stick-slip cycle.

From the conclusions reached as a result of these experiments, it appears that Bowden and Leben have ascribed properties to kinetic friction that in reality belong to their particular apparatus. The temperature flashes which occur only during the slip are to be expected and are due to dissipation of energy at this time. Melting temperatures are ordinarily not reached although they may readily be attained if the rate of generation of heat is large, due to high speeds or high loads; if the melting point of one of the metals is very low, or if heat cannot be conducted away as fast as it is generated. Nor is melting necessary to establish the stick-slip behaviour. This is evident from the fact that the slider sticks to the moving plate in the beginning, that is, before the very first slip occurs and consequently before any temperature flash takes place. A. H. N.

583.* Examination of Used Crankcase Oil. L. L. Davis. *Refiner*, April 1942, **21** (4), 107.—The depreciation of an oil in service results from contamination from two major sources: (1) From sources external to the lubricating system. These extrinsic contaminants (such as those from the combustion zone) depend on the mechanical conditions of the engine, and are not a consequence of the kind or quality of the lubricant. (2) From sources inherent to the lubricating system and to the oil. These intrinsic contaminants result from the changes in the oil, and therefore depend on the quality of the oil as well as on the operating conditions.

The various methods most commonly used for the estimation of the changes that have occurred in a used oil are: (1) dilution by the fuel; (2) water content; (3) viscosity; (4) carbon residue; (5) neutralization number; (6) ash; (7) metal content; (8) naphtha insolubles; (9) chloroform insolubles; (10) chloroform solubles; (11) oil insolubles; (12) resin content. Due to the infinite number of possible combinations of oils, engines and operating conditions, the interpretation of the results of used oil analysis depends on a knowledge of the oil used, the type or make of engine, the service conditions,

and the condition of the engine after use. Such interpretation includes an evaluation of the quantity and character of the various contaminants in the used oil. These are discussed as extrinsic and intrinsic contaminants. Discussions are further made of asphaltenes; carbon residue, the viscosity and neutralization number of an oil; and of corrosion. Correlations are attempted, and the conclusion is reached that engineers engaged in research may obtain considerable reliable information from a study of the detailed analysis of the used oil in relation to engine conditions. This relationship is too complex to be used for control of routine operation by either the individual or the fleet owner. The correct period between drains must be determined by practical experience with representative oils, in specific equipment, and under given operating conditions. It must primarily be based upon engine conditions, although detailed oil analysis will assist in developing optimum drainage periods. To insure protection of equipment, such drainage periods should be substantially shorter than the indicated maximum useful life of the oil.

In general the recommendations of the equipment manufacturer or the oil company are on the conservative side in order to protect the consumer from troubles which might arise under severe conditions. Certainly, if equipment must be kept in condition for maximum performance under severe conditions, a conservatively short crankcase drainage period is to be recommended.

After the correct drainage period has been determined from experience in service, a drainage schedule in hours or miles of operation should be established and rigidly enforced. The paper ends with a list of standard and other test methods for oils.

A. H. N.

Special Products.

584. Sugar-Cane Wax. Anon. *Chem. Tr. J.*, 26.12.41, **109**, 322.—The U.S. Dept. of Agriculture have investigated the extraction of wax from sugar-cane, and are to set up a pilot plant at Houma, Louisiana. The industry was originally established in Natal during 1914–18, using the discarded mud press-cake (since it was not practicable to extract the wax from the cane before clarification). Some 12 million lb. are stated to have been exported in 1924, in spite of disadvantages such as stickiness, and dark colour difficult to improve owing to residual fatty matter, and in some cases an objectionable odour, due to the putrefactive decomposition to which it is subjected to reduce the fat content.

In Louisiana extractions of different mud press-cakes have been made, toluene being the recommended solvent. Fatty fractions can be removed by extraction in the cold with, *e.g.*, acetone to give a range of waxes, the solvent being removed by distillation and blowing the wax with steam or air.

C. L. G.

585. Peroxide from Propane. Anon. *Chem. Tr. J.*, 2.1.42, **110**, 11.—English Patents 540,534 and 541,110 of 1941, taken out by the Bataafsche Petroleum Mij., cover the production of hydrogen peroxide and organic peroxides from gaseous saturated hydrocarbons with two or more carbon atoms and saturated alicyclic hydrocarbons by incomplete combustion at, *e.g.*, 400–500° C. at a volume ratio of hydrocarbon to oxygen of at least 4 : 1. The gas mixture is admitted with turbulence into the walls of the vessel, which is made of non-rusting metal, being eventually burnt in the centre of the vessel. The reaction product is then rapidly discharged and cooled at, *e.g.*, 40° C., so that a portion of the by-products formed (H·CHO and CH_3·CHO) remains in the vapour phase. Contact between the peroxide and the metal at high temperatures is avoided by cooling the reaction vessel to below 200° C. with, *e.g.*, ethylene glycol. An example is given of the combustion of 70 c. metres per hour of a mixture of 98% vol. C_3H_8 and 10% O_2, yielding 8 litres of an aqueous solution containing chiefly H_2O_2 (20 mgm. equivalent of oxygen per cc.). By recycling a portion of the reaction gases with more oxygen and propane, the yield may be increased to about 60 litres.

C. L. G.

586. Physical Characteristics of Synthetic Rubbers. J. N. Street and J. H. Dillon. *J. Appl. Phys.*, January 1942, **12** (1), 45–56.—A summary of the nature and special applications of the more important types of synthetic rubbers is given. Two series

of rubber and synthetic rubber stocks, compounded on the basis of comparable pigmentation, were selected for study. In addition to the conventional physical properties (tensile strength and elongation at rupture, modulus, ageing, etc.), a number of other mechanical properties, such as dynamic rigidity, hysteresis loss, "blow-out resistance," "running temperatures," and tensile strength at elevated temperature were measured. Swelling tests in various solvents were also made. Results are plotted in the form of correlation charts in an effort to select proper methods of measurement. Some observations on comparative service tests in tyres in the case of three synthetic rubbers, indicate them to be satisfactory, on a quality basis, for use in time of emergency. The importance of care in selecting the proper physical tests and methods of analysis is emphasized in the light of the results given. It is concluded that rubber testing techniques and interpretation must be modified in certain instances in evaluating synthetic rubber stocks. A. H. N.

587.* Hydroforming Process Now Used on Commercial Scale. M. H. Arveson. *Oil Gas J.*, 15.1.42, **40** (36), 53.—In the course of the hydroforming process a certain amount of polymerization occurs as side reaction, resulting in the formation of 2% or so of a polymer of complex aromatic character. The general characteristics of the polymer are: A.P.I. grav. 11.0, spec. dispersion 264, A.S.T.M. distillation I.B.P. 448° F., 50% over at 490° F., 90% over at 620° F. Properties of 65% and 80% overhead cuts from the polymer are also quoted. A high content of polycyclic aromatics is indicated by the properties shown. The total quantities likely to be available from plants under construction and definitely planned in the U.S. is 10 million to 15 million gals. per annum. Various tests which have been carried out on the polymer and on distillates indicate that they will be of value as an improved high-boiling rubber solvent, as solvent for paints, lacquers, etc., as component of paint removers, as solvent or plasticizer in connection with natural and synthetic resins, rubber, bakelite compositions, etc., as solvent for asphalt and gilsonite impregnating compositions, as component of insulating and cable oils, as ingredient of preservative compositions for application to wood and other materials of construction and also wrappings, as preventitive of deposition in gas-mains, as absorber oil, as heat-transfer medium, as a flushing oil, as stabilizer for fuels against sediment formation, as component of insecticide and printing inks, as high-octane blending agent for tractor fuels, etc. Both polymer and its distillates have octane ratings of about 90 motor method clear and blending octane numbers of 95–120. It is expected that the polymer will become a material of importance in the industry. R. A. E.

Detonation and Engines.

588.* Ignition System as Influenced by Fuel Characteristics. J. T. Fitzsimmons. *Soc. Aut. Engrs. J. (Trans.)*, 1942, **50** (1), 15–19.—Fuels of the same A.S.T.M. octane rating may differ widely in detonation characteristics when used in an engine over a range of speeds, as has been shown by co-operative tests to determine the spark advance for borderline knock throughout the speed range. Modern high-compression engines have become more critical as regards the design of automatic advance mechanism to combine maximum power with freedom from detonation on a variety of marketed fuels. The author suggests means of utilizing borderline knock tests, on all fuels which are likely to be used in practice, so as to obtain substantially knock-free operation with the minimum sacrifice of power.

Manufacturers commonly hold automatic advance curves within a tolerance of 3 to 4 engine degrees. This seems reasonable, since fuels of the same A.S.T.M. knock rating differ as much as 20° in spark requirements over the complete speed range, whilst engines vary as much as 18° between cylinders as a result of variations in compression ratio, temperature, and mixture conditions. The widest commercial tolerance on synchronism of timing from one cylinder to another is 3°, with more than half the units showing only about 1·5°. However, in many engines a great deal of accuracy is lost through distributor drive backlash, end-play in spiral gears and torsional vibration. K. A.

589.* Bearings for Heavy-Duty Automotive Engines. A. B. Willi. *Soc. Aut. Engrs. J. (Trans.)*, 1942, **50** (2), 62–72.—Tin-base babbitt has many advantages as a bearing material, but its strength and hardness decrease rapidly at high operating temperatures. The demand for higher-capacity bearing materials has been met by the development of certain cadmium alloys and copper–lead mixtures. The load capacity of babbitt has also been increased by developing methods of manufacturing steel-back bearings with a lining of babbitt as thin as 0·0025-in. Very thin linings require special precautions as regards efficient air-cleaners and oil-filters to guard against scoring by foreign particles in the oil-stream. Requirements of economy and availability necessitate the use of corresponding thicker linings in replacement bearings for undersize shafts.

In a discussion of replacement bearings, the unfavourable effects of the following conditions are emphasised: worn and out-of-round journals, bowed crankshaft, warped crankcase, oval bearing bores, dirt within the engine, displaced bearing caps and improper clearance. Correct grooving is important, and it is shown that the addition of a centrally located internal annular groove will improve the load capacity of bearings with a high L/D ratio.

Increased use of copper–lead bearings may be enforced by shortage of cadmium and tin. These are less tolerant than babbitt of misalignment, incompatible oils, etc. It is a normal characteristic for copper–lead bearings to acquire a surface deposit, which may be one of three types:

(1) A hard orange, brown or black lacquer;
(2) A soft, dull-black deposit, associated with the use of detergent oils. There is little evidence that either of the above are harmful.
(3) A *hard dull* black deposit, definitely associted with corrosion, and possibly accompanied by surface pitting.

Corrosion may be due to high-temperature operation (selective lead loss) or low-temperature operation (selective copper loss), *i.e.*, heavy flow-by, poor crankcase ventilation and excessive idling. Fifteen rules are given for the installation of copper–lead bearings. K. A.

Coal and Shale.

590.* Natural Gas from Coal. Anon. *J. Inst. Fuel*, 1941, **15**, 81, 67.—An account of an article by L. Ranney (*Eng. Expt. Station News, Ohio State Univ.*) in which the possibility of recovering methane from coal *in situ* before mining is examined.

Coal is stated to be as permeable to gas as is the ordinary gas-sand of the natural gas-fields of America. An evacuated bore-hole will drain the methane from the coal within a 400-ft. radius. The suggested scheme consists of drilling horizontal holes through the coal-seam from mine workings, the holes being up to a mile in length and spaced at 800-ft. intervals.

It is claimed that such a scheme would recover 800–2000 cu. ft. of gas per ton of coal and would reduce ventilation costs and explosion hazards in coal-mines. C. G. G.

Economics and Statistics

591. World Oil Consumption in 1941. V. F. Garfias, R. V. Whetsel, and J. W. Ristori. *Oil Gas J.*, 12.2.42, **40** (40), 13.—The total world consumption of petroleum and its substitutes in 1941, excluding that for military purposes except in the U.S., is estimated to have been 2067 million brls., which is greater than the consumption in any previous year. Demand for military purposes, including addition to stocks, is estimated to have been 304·5 million brls. in countries outside the U.S.A. Consumption in the U.S.A. totalled 1492 million brls., of which motor fuel accounts for 671 million, kerosine 70 million, gas and fuel-oil 560 million, and lubricants 32 million brls. In Japan, production is estimated to have been 8·2 million brls., and civil consumption, based on 20% of that in 1938, 5 million brls. In other Axis-controlled countries production is estimated to have been 89 million brls. and civil consumption at 20% of that in 1938, 37 million brls. A table shows consumption of various products by countries. R. A. E.

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Geology and Development.

592.* Important Reserves may Exist in Sedimentary Structures Formerly Overlooked. N. C. Smith. *World Petrol.*, Feb. 1942, **13** (2), 30.—The possibility must be considered that favourable conditions exist for the accumulation of substantial amounts of petroleum solely controlled by primary sedimentational features. If such conditions occur and the resulting reservoirs are accessible to migrating petroleum, then the aim must be to search for the attributes which will aid in their location. The following are depositional features—pinching beds, reefs, lenses, porosity variations due to grain size and other primary sedimentary causes. Many have noted the association of oil accumulations with pinching beds, reefs, and lenses.

Considerable and irregular changes of grain size and rapid variations in thickness are typical developments in beds of the shoreward portions of the neritic zone and adjacent areas. Tides, winds, storms, and currents lead to interstratification of sands and muds, or to complicated lensing of sands and mud. Grain-size distribution

depends on the transporting capacity of water, and rapid changes of transporting capacity are characteristic of the neritic zone. The greater the angularity, the greater the sorting and the less the orderliness of arrangement, the greater will be the porosity in general.

Littoral oceanic currents are believed to induce eddy currents in the lee of promontories, causing characteristic concave and convex curvature in the coastline, and such curved forms may be related to the size distribution of the sediments.

Where the sea-floor is ridged, the velocity of the moving water will be greater over the ridges than in the depressions, and so the sediments will be coarser on the ridges than in the depressions.

The formation of intercalated beds may be the result of (*a*) exposure and dissection of the uppermost sediments laid down by a retreating sea; (*b*) reworking of the debris by the waves of an advancing sea; (*c*) final deposition and burial.

Although new methods may be developed for the detection of significant porosity variations, one of the first steps in the search for reservoirs controlled by porosity variations should be to study the great store of cores and records, surface geological data, and geophysical and geochemical surveys, and to re-interpret them with the sedimentational features in mind in order to reconstruct past conditions. G. D. H.

593.* Coordination and Research Hold Future to Oil Exploration. J. A. Kornfeld. *Oil Wkly*, 20.4.42, **105** (7), 42.—War needs require the discovery of important reserves near big-scale transportation facilities which will remain effective during the conflict, and also the furnishing of oils providing high-octane fuel and heavy fuel oil. The past few years have shown a declining rate of discovery, as well as few major discoveries.

Exploration policy has hinged around structural features, and this is now in the phase of diminishing returns, and to increase discovery rates demands a shift in exploration thought to the stratigraphic features. The change will involve financial risks, regional geological studies and stratigraphic core-drilling. Subsurface geological work should be directed towards the recognition of the existence, location and character of unconformity zones, whether structural, palæontological, or lithological. Cross-sections on a regional scale from the surface to the basement should be constructed. Regional isopach and conveyance maps should also be prepared. Careful study should be made of all types of well-survey charts.

There seems to be much in favour of the formation of a separate department charged solely with exploration, and the programme should be based on a long-term policy as far as possible. G. D. H.

594. Possibility of Future Discoveries in Eastern Colorado. F. N. Bosco. *Oil Gas J.*, 16.4.42, **40** (49), 66–68.—Eastern Colorado has six oilfields, and some closed-in gas structures. The Florence–Canyon City field has produced 13,500,000 brl., and is still giving oil at the rate of 35,000 brl./year. The oil is in fissures and flexures in the Pierre shale on the east limb of a syncline. The Boulder field has a dome and a plunging faulted anti-clinal nose with oil accumulated down-dip from minor transverse faults. Oil is obtained from the Hygiene (?) sand or from fissures in the Pierre shale. The wells are 200–3400 ft. deep, and the cumulative production is 645,379 brl.

A gentle, elongated, anticlinal fold gives shallow oil at Berthoud. Small amounts of gas have been found in a dome in the Beecher Island area.

Eastern Colorado has many oil-seeps and oil-saturated outcrops. Closed anticlines, anticlinal noses, and structural terraces, fault-traps, and fissuring are likely to cause oil-accumulating in this region, but the relationship to other structures, local or regional, to faults and to the possibility of artesian flushing must be borne in mind in assessing the value of structures. Stratigraphic traps may be expected in this area.

The Fort Collins–Wellington field lies on the west flank of the Denver–Cheyenne basin. A north–south anticline is divided into two parts by a saddle, and both the Wellington and Fort Collins structures have a steep western flank. West of the saddle is the Douglas Lake structure. Until 1939 production was wholly from the Muddy sand, and then a few wells found oil in the Lakota on the Fort Collins structure.

A Muddy sandstone lens, sealed up-dip by a fault, is the trap at Greasewood. The sand is about 6700 ft. deep, and while the production so far has not been high, the structure suggests that other accumulations may occur in the vicinity. G. D. H.

595.* Paloma Field Extended One Mile East by Small Well. L. P. Stockman. *Oil Gas J.*, 9.4.42, **40** (48), 68.—The Paloma field of Kern County, California, may be extended 1 ml. east, although the well may not be a large producer, since there is only 50 ft. of oil-sand. The well is 11,811 ft. deep, the oil zone being at 10,935–10,985 ft. After gun-perforating, a little high-gravity condensate and 190,000 cu. ft. of gas flowed.

In the Jacalitos district of Fresno County commercial production was found a short time ago in the Temblor at a relatively shallow depth. The oil-sand is 25–50 ft. thick and about 4000 ft. deep. G. D. H.

596.* Haynesville Field has Renewal of Activity. G. B. Nicholson. *Oil Wkly*, 6.4.42, **105** (5), 30.—The Haynesville field, after producing for 21 years, and appearing to be slowly approaching abandonment, has taken a new lease of life with the discovery of important deep production in the Pettit lime at 5448 ft. The old producing zone was the Blossom at 2800 ft.

Low Pettit permeability in the discovery well gave little hope of success, but acidization led to a flow of 1500–2500 brl./day on open flow, and 384 brl./day on a ¼-in. choke. The gravity of the oil is 40–41°, and the bottom-hole pressure 2123 lb./in.². A second Pettit well was brought in 1¾ ml. north of the first, being an abandoned 11,000 ft. well, which was perforated in the Pettit zone.

The Pettit is oolitic.

Other successful wells have been drilled, and indicate probable production over a greater area than the Blossom, which covered 7480 acres.

Haynesville is a dome discovered from surface geology. Gas was found in the Glen Rose at 4330 ft. and a non-productive oil-sand was discovered below 4500 ft. The Blossom has given 71,631,940 brl. of oil.

The Pettit wells have a low gas–oil ratio and give little water. An 80-acre spacing is in force. G. D. H.

597.* Wildcat North-west of Emma Pool Shows Oil in New Pay. R. Ingram. *Oil Gas J.*, 9.4.42, **40** (48), 77.—There are indications of an oil strike 2 ml. north-west of the Emma pool in southern Andrews, County Texas. Oil-staining was found at a depth of 4485–4495 ft., and a core at 4495 ft. showed limestone bleeding oil. There is no production at present in south Andrews County at this depth, but another wildcat has had a showing at a similar depth.

¼ ml. south of the Ector County part of the West Andrews pool a well has found oil at 4192 ft., while in the Fullerton area of north-western Andrews County a second well has reached 6680 ft., the first well having found its first pay at about 7000 ft.

G. D. H.

598.* Half-billion-barrel Gain in U.S. Reserves Shown by A.P.I. Anon. *Oil Wkly*, 30.3.42, **105** (4), 46.—1,968,963,000 brl. of new oil were found in U.S. during 1941, some 564,781,000 brl. more than the production in that year. The net increase raised the total reserves to 19,589,296,000 brl. on 1st January, 1942. Most of the new oil was added by upward revision of fields found prior to 1941, and this amounted to 1,538,989,000 brl. The estimates include only reserves in known and proved fields, and recoverable by present production methods.

Tables show by states the proved reserves on 1st January, 1941, 1st January, 1942, the new reserves discovered and developed in 1941, the production during that period, and the reserves of the new pools found in 1941. G. D. H.

599. Arvin Area of Mountain View Oil-field. F. E. Kasline. *California Oil-fields, Summary of Operations*, Vol. 24, No. 4, April, May, June 1939.—The main Arvin field, which, as its name implies, lies near the town of Arvin, about 14 miles south-east of Bakersfield, Kern County, California, was discovered in February, 1939, when the Standard Oil Co. of California completed "Jewett Community Lease No. 2" well in the Chanac sands. From this an initial yield of 3024 brls. of 31·4° A.P.I. gravity oil was obtained at a depth between 6060 and 6270 ft. The second well completed was not so successful, since, although the well flowed at a rate of nearly 800 brls. of 30° gravity oil, the water cut was 23·2%.

According to this report, twelve more wells were completed between 1st May and 31st December, 1939, to depths ranging from approximately 6100 to 6500 ft. Initial productions varied from 200 brls. to 2400 brls., with the majority between 1000 and 1900 brls.

Production in the Arvin field is obtained from an aggregate of about 70 ft. of oil-sand in a 200-ft. interval of predominantly continental clays, siltstones, and sands (Chanac, Pliocene). Oil accumulation is in faulted homoclinal strata against a major fault seal trending north-west–south-east. H. B. M.

600. Premier Area of the Poso Creek Oil-field. F. H. Updike. *California Oil-fields, Summary of Operations*, Vol. 24, No. 4, April, May, June 1939.—In the area known as the Premier Area of the Poso Creek Oil-field, the productive land lies in a narrow strip 3 miles long, running north to north-west, about 10 miles north-west of Bakersfield, Kern County, California. This report states that commercial production was obtained by the Ohio Oil Co. in April 1929, when No. " Midway Premier " 1 Well was completed and an initial yield of 190 brls. of 13·4° A.P.I. gravity oil obtained daily from 2804 ft. Subsequently no further wells were sunk until 1934, when a second well was completed to a depth of 2690 ft. with an initial production of 260 brls. of 13·4° gravity oil daily. During 1936–37 a total of thirty-three wells was drilled with initial yields as high as 200 brls. per day. This production, however, showed a rapid decline to an average of 17 brls. daily per well.

In July 1941 a total of seventy wells were producing from the field with a total daily average production of 1160 brls. of oil. The proved land, which includes practically all the potential producing area, is about 730 acres, and limited on the east by a main fault, on the north by cross-faulting, and on the west and south by edge-water. H. B. M.

601. Canal and Strand Oil-fields. R. W. Walling. *California Oil-fields, Summary of Operations*, Vol. 24, No. 4, April, May, June 1939.—The Canal and Strand oil-fields are situated about 1½ mile north-west of Ten Section field, and approximately 14 miles south-west of the city of Bakersfield, Kern County, California. When the area was explored evidence pointed to the structures of these fields as being minor to those of Ten Section field. Consequently their exploitation was postponed in favour of the major project.

The history of Canal field as given in this report indicates that the first well was completed in November 1937. This was drilled and cored to a depth of 8175 ft. During the first 24-hour period the well produced 2267 brls. of 36·9° A.P.I. gravity oil. Development has been confined for the most part to the 900 ft. of " Stevens " zone (Miocene), which consists predominantly of friable, medium-grained, massive sands with occasional siltstone and hard sandstone-shell breaks.

Up to 31st December, 1940, thirty-nine wells had been drilled, of which thirty-eight were successfully completed. Initial potential rates of production varied from 522 to 3390 brls. of oil per day. Total production from the field up to that time was 4,767,574 brls. of oil and 5,284,023,000 cub. ft. of gas, in spite of drastic measures in force to prevent excessive production.

The Strand field was proved with a well sunk by the Tide Water Associated Oil Co. in June 1939, which was drilled and cored to a depth of 8364 ft. and which produced 1130 brls. of 34·0° A.P.I. gravity oil in the first 24-hour period. Up to 31st December, 1940, ten wells had been successfully completed, drilling was suspended in one, and one was in process of being drilled. Initial potential rates of production varied from 349 to 3638 brls. of oil and 2,333,000 cub. ft. of gas per day, and averaged 2197 brls. of oil and 1,535,000 cub. ft. of gas. Up to 31st December, 1940, 668,391 brls. of oil and 418,777,000 cub. ft. of gas had been produced from the field. H. B. M.

602.* Africa Without Important Production is Big Potential Market. K. N. Goss. *World Petrol.*, February 1942, **13** (2), 40.—Egypt is the only country in Africa which produces an appreciable quantity of crude oil, but its geographical position makes its output of more importance to the Near and Middle East than to the continent of Africa. The oil output from torbanite in South Africa is only 10,500 tons, against the country's annual consumption of over 1,100,000 tons, and only 2000 tons of motor

spirit are derived from coal-tar. Oil-shows occur in the Karroo, but they give little hope of commercial accumulations at depth. Workable deposits of oil-shale are known only in the Ermelo district, although the Union is rich in coal, making hydrogenation or the Fischer–Tropsch process a possible source of oil. A relatively small amount of oil-shale is known in Madagascar, where small amounts of oil have been found by drilling.

A little oil is produced in Algeria, and French Morocco has a rather higher output. Gas and traces of oil have been found in Tunisia. Oil seepages and bituminous sands occur in the Cameroons. Three wells have been drilled in French Equatorial Africa. French West Africa also has shows. Test wells have been drilled in the Gold Coast Colony and in Angola without commercial success, while others have been drilled in Abyssinia, in Eritrea, on Great Dahlac Island and in British Somaliland. There has been exploration in Kenya, in the Belgian Congo and Mozambique, again without success.

In 1938 the African oil consumption was 4,400,000 tons, most of which had to be imported in the refined state.

Africa possesses rich sources for the production of vegetable oils of all kinds.

G. D. H.

Geophysics.

603.* Striking Expansion in Geophysical Operations. E. A. Eckhardt. *Oil Wkly*, 20.4.42, **105** (7), 38.—Since May 1941 there has been a striking expansion in geophysical prospecting in U.S.A.

New discoveries in 1941 added 429,974,000 brl. of oil to the U.S. oil reserves, a quantity which is only 30·6% of the 1941 production, but upward revision of estimates for previously discovered pools added 1,538,989,000 brl. to the reserves, so that the net increase in reserves was 564,781,000 brl. 170,364,000 brl. of the new reserves are in Texas, 62,946,000 brl. in Illinois, 58,911,000 brl. in Oklahoma, and 47,915,000 brl. in Louisiana. 39% of the 1941 seismograph operations were carried out in Texas, 29·4% in Louisiana, and 27·2% in Oklahoma.

Over fifty gravimeter parties were operating in 1941, and about nineteen magnetometer parties. Geochemical, electrical, and torsion balance work were carried out on a restricted scale, some of it sporadically. Neither the prospects nor the acceptance of geochemical work made any notable progress during 1941. G. D. H.

604.* Advanced Geochemical Well-logging. J. W. Merritt. *Oil Wkly*, 30.3.42, **105** (4), 32.—Chemical well-logging does not claim to supplant other forms of well-logging, but it is an excellent correlative tool in oil-well testing. Studies of chemical well-logs have shown that it is possible to detect the approach of the drill towards an oil or gas horizon several hundred feet before the drill has reached the horizon. Indications may also be given of the type of oil or gas horizon.

The geochemical log may prevent the abandonment of a well which if taken a little deeper might obtain oil, while if the intended horizon has been attained and the log gives negative indications, needless expense and additional drilling may be avoided. Favourable or unfavourable spots for coring may be indicated in advance, and the best position for running casing may be shown by signs of the nearness of an oil-sand. There may be lateral indications of oil in a horizon.

A gas horizon is shown by light fractions in the cuttings, and an oil horizon by increasing light fractions followed by heavier fractions. The hydrocarbon values generally drop off sharply on passing the pay horizon.

Carbonaceous shales give high hydrocarbon values, but give no evidence in the overlying beds. G. D. H.

Drilling.

605.* Horizontal Wells from Shaft to be Used in Pennsylvania. A. C. MacIntyre. *Oil Gas J.*, 9.4.42, **40** (48), 42.—The paper describes what may prove to be the first large-scale test of the horizontal drilling theory in the world. Plans call for the sinking of a circular shaft, 8 ft. in diameter and about 400 ft. deep, into the Venango First sand near Franklin, Venango County, in the Middle district of the Pennsylvania region.

The oil in that sand is known as the Franklin heavy crude, and has an unusually high lubricating content, and less gasoline and other light distillates than any other crude produced in Pennsylvania.

The Middle district seems to be the best testing place for the operation, since the oil-sands are at the shallowest point in the Pennsylvania region. The oil content per acre is not as great as in the Bradford–Allegany fields, where water-drive has proved successful. The Middle district sands do not lend themselves to water-drive, but air- and gas-drives have proved successful. Reserves recoverable by present methods, according to a recent survey, are greater in the Middle district than in any other area of the Pennsylvania region. The properties of the crude are briefly given.

The shaft is dug, not drilled, about 400 ft. deep, which takes it into the sand. It is 8 ft. in diameter. The working chamber at the bottom of the shaft is also circular, and 27 ft. in diameter. Both shaft and chamber are lined with 12 and 18 in. of concrete. The shaft enters the chamber at one side, and not in the centre. No gas, oil, or water is allowed to enter the shaft or work-chamber.

It is anticipated that 3-in. holes will be bored horizontally from the working chamber into the face of the sand, and will extend up to distances of 2000 ft. Under the proposed plan the oil will flow by gravity from the horizontal holes into a pump at the bottom of the working chamber, by which it will be lifted to the surface.

Earlier work by Mr. Ranney, the inventor of the method, is summarized. A. H. N.

606.* Present Position of the Drilling Contractor. B. Mills. *Petrol. Engr*, April 1942, **13** (7), 48.—A brief historical review is given of the contractors' rôle in oil-well drilling, beginning with the Drake well of 1859, which was drilled under contract. Drilling contractors annually complete more than 75% of all wells drilled in the U.S.A. There are approximately 250 such contractors in that country, and this surprising total includes organizations equipped to meet every drilling requirement. They normally employ between 75,000 and 100,000 persons, and actually support several times that number. Between 4000 and 4500 rotary drilling rigs, and between 2800 and 3200 cable-tool drilling rigs are available for immediate use in the U.S.A.; of these totals, drilling contractors own and operate about 75%.

A very light-weight rotary drilling outfit costs about $25,000; a medium-weight rotary drilling outfit approximately $60,000; a very heavy type steam drilling rig as much as $125,000; a gasoline or butane rig about $140,000, and a heavy diesel-electric rig represents an outlay of almost $200,000. Cable-tool drilling rigs cost from $7500 to $25,000, but they are as essential to maintenance of oil reserves as rotary tools. These values represent original cost, and should not be regarded as the present worth. All drilling equipment depreciates rapidly, and replacements are numerous.

The service life of a drilling rig is difficult to determine as a single unit. Many of the major items last several years, whereas other items wear out in a short time. Frequent replacements will obviously be necessary to carry on normal drilling operations in any area. The average service life of a drilling outfit is 4 or 5 years when based on normal rates of depreciation. This means that whereas some of the items must be replaced several times in 4 or 5 years, others will remain serviceable throughout the entire depreciation period. Such items as wire-line, bits, and drill-pipe are not ordinarily depreciated as much on a time basis as on a service basis. Equipment receiving fairly uniform service lasts longest, and is usually depreciated on a time basis. Boilers, derricks, pumps, engines, and draw-works have a comparatively long service life.

The cost of drilling and equipping a well in the U.S.A. varies from $1000 in the very shallow districts to $200,000 in the deepest producing areas. The average drilling cost is about $21,000 per well. The cost/ft. varies from $1.50 to $15.00. The average drilling cost in the U.S.A. is about 7.00 dollars/ft., including materials necessary to place the well on production. A. H. N.

607.* Complete Detonation in Well-Shooting. F. R. Coxzens. *Petrol. Engr*, April 1942, **13** (7), 54.—Solidified nitroglycerin, commonly termed gelatin, is rapidly gaining prominence as a well-torpedo in eastern oil-producing areas. Under certain conditions its results appear to equal, and even to surpass, those of liquid nitroglycerin, as the solidified form, which may be had in various types and strengths, is less sensitive

and can be pressed by a qualified shooter into crevices and pockets of a sand-face to give the utmost in blasting efficiency. The correctly loaded shot cracks and crumbles the sand-face, exerting equal force in all directions against it, and following, of course, the lines of least resistance. These lines should be the small cracks and porous structure that are a natural condition in a producing sand, thus such cracks are enlarged and amplified. Certain shooting jobs are, however, ineffective due to partial detonation.

Practically all detonating agents, with the exception of the time-bomb, which is not generally used, expend their force at the extreme top of the explosives pack. This point of detonation gives every opportunity for compression of the centre and lower masses of the charge, where, if detonation does occur, unexploded particles are almost certain to be blown into the spoil or residue that is being forced from the well. The smaller the diameter of the well, the more likely this is to occur. Tests conducted under actual oilfield conditions have proved conclusively that the most effective results are attained when the detonating agent contacts the centre of the explosive pack, as well as its top and bottom. In wells 4 in. or less in diameter at the bottom, when a torpedo shell is used to house the explosives, electric blasting caps should be attached to the firing wire at intervals of 2 ft. along the entire course of the torpedo. The method is described in detail. A. H. N.

608.* Mud Programmes Important in Drilling Abell Field Wells. D. H. Stormont. *Oil Gas J.*, 9.4.42, **40** (48), 35.—Drilling in the Abell field is generally considered to be the most difficult in the Permian Basin. The hard formations encountered require rock-bit digging all the way, whilst the faulted conditions of the structure, the variance in depth of markers, and lack of uniformity of saturation in the field's six pay horizons all make for much coring. Sulphur-water flows and high-pressure gas are encountered in varying degrees throughout the field, and at most wells trouble is encountered with lost circulation.

Because of the numerous variations in the formations and in the pressures carried by them, operators have found it impossible to adopt a specific mud programme that can be used for every well. Accordingly, the general practice is to establish a mud programme that has proved satisfactory on the nearest producer, and then make changes to deal with any abnormalities encountered while drilling.

That such a procedure is proving successful is reflected in a comparison of mud costs of the first few wells drilled with those more recently completed. Total mud costs for twelve wells drilled early in the field's life, representing a total of 60,493 ft. of drilling, was $21,487, or 35·5 cents/ft. For five wells completed more recently the total mud cost for 22,410 ft. was $5201, or an average of 23·2 cents/ft. Thus the average mud-cost for a 5500-ft. well has been reduced from $1952 to $1276, or a saving of $676 per well. Furthermore, some wells are now being drilled with a total mud-cost of less than $900, or about half the cost of earlier wells.

In addition to this saving, the frequency of blow-outs has been reduced. One well that got out of control while drilling through a sulphur-water horizon had a total mud-cost of almost $12,000. Careful control of mud properties is therefore paying even greater dividends than the above figures indicate.

The problems encountered in surface and deep drilling are detailed, and a typical table of mud programmes is given in full, with explanations. A. H. N.

609. Deep Rotary Drilling in Michigan. G. C. MacDonald. *Oil Gas J.*, 16.4.42, **40** (49), 39. *Paper Presented before American Petroleum Institute.*—The drilling of the deepest well in Michigan, the Gulf 1 Bateson, was one of the most interesting episodes in that State's oil history. Numerous difficulties were encountered which required application of the most advanced techniques known to drilling. The experience gained and the information accumulated will be of great value in future deep development in the State.

These are given in detail, giving dimensions, properties of fluids, and field information.

Now that the subsurface conditions are known, it should be possible to drill a similar well in the same area with a fraction of the expense and difficulty encountered in 1 Bateson. The greatest drilling difficulties undoubtedly occur above 5000 ft., and if that section were adequately cased off with an intermediate string of pipe, most of the difficulties encountered in drilling 1 Bateson would be eliminated. The lower 5000 ft.

of hole could undoubtedly be drilled more rapidly than the upper 5000 ft. It is true that abnormal gas pressures would probably still be present in the Salina formation, but the very fact that their existence is now known would contribute immeasurably to the successful handling of those pressures.

Certain alterations in the mechanical equipment would further increase the ease and safety of drilling additional wells. A salt-water base mud would reduce enlargement through the extensive salt section. A flooded pump suction is extremely desirable whenever mud of any such weight as 17 lb. to 18 lb./gal. is used. A. H. N.

610.* Cement Slurry to Fit the Job. W. A. Sawdon. *Petrol. Engr*, April 1942, **13** (7), 23–26.—Cementing companies have developed techniques that have insured very high efficiency in the handling of the cement at the surface, providing speed and consistency of mix at whatever pumping pressure may be necessary. The planning of the job, the proper preparation of the hole, the amount of cement to use, the selection of the kind of cement, and the determination of the water–cement ratio are, however, dependent on down-hole conditions known only to the operator. These points are discussed and amplified.

By preparation of the hole is meant not only putting it in the best condition possible to take the cement, but also providing the casing string with equipment that will help ensure a successful job when such equipment is necessary. This applies mainly to casing jobs, as the condition of the hole and the equipment in place are usually fixed quantities when re-completion or repair work is to be done. The selection of the casing point is important, but existing conditions sometimes preclude the use of the most desirable casing point.

When cement is placed against porous formations, the mud-cake formed on those formations during drilling will interfere with the bond of the cement with the formation, and will sometimes start channelling. A study of channelling, the effects of mud-cake on the bond, and the relative value of various mechanical devices and chemical means for the removal of mud-cakes was made about two years ago by one of the major oil companies in California. These studies indicated that the mud-cake formed on formations having appreciable permeability will remain between the set cement and the formation unless specific means are employed to effect its removal; and that whereas the movement of the casing and circulation of water may reduce the thickness of the mud-cake slightly, they will not remove it completely.

The quantity and quality of cement slurries and their dependence on various factors are next discussed in detail. Temperature and pressure effects are studied in particular.

Squeeze-cementing is also discussed. So far as is now known, the effectiveness of squeeze-cementing off water- or gas-bearing sands depends on the permeability of the formations and the ability of this permeability to provide for the formation of a cement filter-cake on the face of the sand. Numerous tests made by various companies indicate that cement applied to water- or gas-sands commonly found in oil-wells does not penetrate beyond the face of the sand, no matter what pressure is applied. These sands, under formation pressure, carry water or gas to the bore of the well, and when a pressure greater than the formation pressure is applies in the well, water or gas will pass from the bore into the formation. While building up this differential pressure during squeeze-cementing operations, some of the water contained in the slurry is squeezed out and forced into the formation. This loss of water causes a cement filter cake to form on the face of the sand. A. H. N.

611.* Wildcat Drilling in 1941 with Some Comments on Discovery Rate. F. H. Lahee. *Oil Wkly*, 20.4.42, **105** (7), 25.—During 1941 11,615,085 ft. of wildcat drilling was done, representing 3264 holes, and, of these, 503 were producers accounting for 2,047,377 ft. of drilling. The southern States had 258 producers out of 1563 wildcats, these amounting to 1,264,774 ft. out of a total of 6,843,749 ft.

Of the wildcats drilled on geological or geophysical information, 471 were successful and 1928 dry. Thirty successful holes were drilled out of 801 located on a non-technical basis. Compared with 1940, there was a considerable increase in wildcatting in California, Texas, Kansas, Louisiana, and Illinois, whereas there was a marked fall in Michigan and Mississippi. The percentage success in technically located

wells rose from 15·6% in 1940 to 19·5% in 1941, but the successes with wildcats drilled without technical advice fell from 4·2% in 1940 to 3·7% in 1941.

Examination of wildcat and reserve statistics for a group of eleven States shows a falling rate of discovery, which is probably largely due to a growing difficulty of finding new geological traps for oil, and a more vigorous wildcatting campaign both as regards numbers and depths seems to be the only way of maintaining a satisfactory discovery rate. A series of tables and curves summarize data regarding wildcatting and reserves.

G. D. H.

612. Completions Decline in March with Small Rise in Drilling. W. V. Howard. *Oil Gas J.*, 16.4.42, **40** (49), 85.—1473 wells were completed in the U.S.A. during March —less than 50% of the total in the peak month of September 1941. Outside the Appalachian region the March completions were 574, compared with 1704 in September 1941. The relative decline in numbers is, on the whole, greatest among the shallow wells.

A survey of wildcat operations over the entire country shows a fall which is nearly proportional to that for the total wells.

Tables summarize by States the operations in all fields in March, and the drilling activity from September 1941 to March 1942.

G. D. H.

613.* Sharp Drilling Decline Begins Levelling Off. Anon. *Oil Wkly*, 13.4.42, **105** (6), 41.—Although U.S.A. well completions fell sharply again in number in March, it seems likely that there will be no further marked decrease in numbers. The March daily average was 36% below that of January, and on 1st April 40% fewer wells were being drilled than in January. 2063 wells were drilling on 1st April, with a further 912 built and shut down. On 1st April drilling had increased in comparison with 1st March in Illinois, Indiana, Kansas, Michigan, Pennsylvania, and West Virginia.

Only 1826 wells were completed in the five weeks ending 28th March. To the end of March 6145 wells had been completed in 1942, and 19,295,141 ft. had been drilled. Tables show by States the rigs in operation on 1st April, 1941, 1st March, and 1st April, 1942, and the status of the wells on the last date; the completions in March 1941, February and March 1942, together with the types of completions in March 1942, and in the first three months of 1942.

G. D. H.

614.* Attractive Wildcat Prospects Keeping West Texas Active. T. P. Sanders. *Oil Gas J.*, 9.4.42, **40** (48), 18.—The need of overland pipe-line transportation in place of the combined pipe-line and tanker system for delivering crude to the eastern United States has led to curtailment of production in West Texas and New Mexico. In January about 466,000 brl./day was being run from the area, but in the middle of March the figure was only 264,000 brl./day. This caused the average production per well to be only slightly over 14 brl./day, and some wells were curtailed to 6 brl./day.

During the first week of January seventy wells were completed in the West Texas–New Mexico area—fifty-four oil-wells, one gas-well, and nine dry holes in West Texas, and eight oil-wells, one gas-well and two dry holes in New Mexico. About a month later there were only twenty-nine completions in the same area in one week.

It is possible that a new trend of production may be developed between the two main trends developed during the past fifteen years. The Fullerton 1 Wilson well in Andrews County produces from the Clear Fork (Permian) sand at 7045–7275 ft. A discovery in Reagan County yields oil from the Ordovician.

Recently a new pay was found in the Big Lake field; this lies at 4200 ft. in the San Angelo (Permian). The other producing sands are at 2400 ft., the San Andres at 3000 ft., and the Ellenburger at 8300 ft. The new pay is not found in wells on top of the structure.

G. D. H.

615. Patents on Drilling. A. L. Parker. U.S.P. 2,277,713, 31.3.42. Appl. 8.9.39. Thread protection for an internally threaded outlet.

E. Schulthess. U.S.P. 2,277,786, 31.3.42. Appl. 18.3.40. Pressure hose.

J. W. MacClatchie and J. L. Chrisman. U.S.P. 2,277,925, 31.3.42. Appl. 16.12.39. Weight indicator.

L. P. Kinnear. U.S.P. 2,277,989, 31.3.42. Appl. 12.12.33. Method and apparatus for drilling wells.

A. L. Rodgers. U.S.P. 2,278,022, 31.3.42. Appl. 6.3.39. Cathead and clutching device therefor.

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R. B. Booth. U.S.P. 2,280,996, 28.4.42. Appl. 16.11.40. Treatment of salt- and lime-cut mud.

R. B. Booth. U.S.P. 2,280,997, 28.4.42. Appl. 20.11.40. Treatment of salt-cut and lime-cut mud.

W. Brauer. U.S.P. 2,281,019, 28.4.42. Appl. 4.4.40. Swivel connection for rotary well drilling.

W. W. Wilson. U.S.P. 2,281,128, 28.4.42. Appl. 15.5.40. Elevator for pipes.

E. K. Lane. U.S.P. 2,281,163, 28.4.42. Appl. 19.7.40. Apparatus for determining the degree of fatigue in drill-pipe and the like.

C. P. Walker. U.S.P. 2,281,301, 28.4.42. Appl. 14.11.40. Means for determining the location of obstructions in wells.

D. U. Shaffer. U.S.P. 2,281,389, 28.4.42. Appl. 25.10.41. Rotary releasing fishing tool.

J. M. Clark. U.S.P. 2,281,414, 28.4.42. Appl. 7.11.40. Combined bridge-plug and drillable whipstock. A. H. N.

Production.

616. Gas-Cycling Increases Recovery. N. Williams. *Oil Gas J.*, 23.4.42, **40** (50), 61.—Gas cycling has been undertaken by owners of combination oil- and gas-wells in the Otis field, in Rush and Barton counties, Kansas, as a means for attaining maximum oil recovery before reservoir pressures in the field are depleted by gas withdrawals for pipe-line outlets. Production allowables have been predetermined covering a period of 9 years, 1 year less than the estimated economic life of the field's gas resources. The programme calls for the return to the producing horizon of all gas not taken by pipe-line outlets.

In the engineering report on which the allowable order governing the present long-range production programme is formulated, it was estimated that on 1st May, 1941, remaining gas reserves in the reservoir totalled 108,700 million cu. ft. It was shown that 99,200 million cu. ft. of gas had previously been withdrawn from the reservoir, including 64,000 million cu. ft. for pipe-line sales, 6100 million cu. ft. used in operation of gas wells, and 29,100 million cu. ft. vented by combination wells.

Of the remaining 108,700 million cu. ft. of gas it was calculated that 93,700 million cu. ft. should be recovered if no further venting of gas from combination wells occurred. This calculation assumed an abandonment pressure of 50 lb. at the well-head. Estimated original bottom-hole pressure of the reservoir was 1178 lb. In the withdrawal

of 99,200 million cu. ft. of gas, together with 1,410,868 brls. of oil, as reported in the engineering survey, the bottom-hole pressure, as of 1st May, 1941, had fallen to 660 lb. Assuming a continuation of the present rate of gas production, it was estimated that the recoverable gas would be depleted and well-abandonment pressure reached in approximately 10 years, the period on which the present production programme is based.

The report estimated that the reservoir originally contained 5,912,500 brls. of stock-tank oil, of which 50%, or 2,956,250 brls., should be recovered. Of this, 1,410,868 brls. had been produced up to the time of the report, leaving 1,545,420 brls. to be recovered, providing gas pressures do not fall below the well-abandonment level before all this oil is produced. While the field-abandonment stage is not expected to be reached in less than 10 years, the specified 9-year allowable period provides leeway to assure the recovery of the oil. The allowable schedule calls for a production of 27,200 brls. monthly the first year, 24,000 brls. monthly the second year, 20,800 brls. monthly the third year, 17,600 brls. monthly the fourth year, and 14,400 brls. monthly the fifth year, 11,200 brls. monthly the sixth year, 8000 brls. monthly the seventh year, and 7200 brls. monthly the eighth and ninth years.

The plant is described. A. H. N.

617.* Economics of Gravel-Packing in Semi-Depleted Loma Novia Field. D. L. Harlan. *Petrol. Engr*, April 1942, **13** (7), 83. *Paper Presented before Petroleum Industries Association.*—A detailed study of gravel-packing is given. The most popular current gravel-packing method is as follows: (1) A cable-tool spudder is moved on location, and rods and tubing pulled. (2) The inside of the liner is bailed clean of mud and sand, using a sand-pump. (3) The top and bottom of the liner are checked with a measuring line to assure correct measurements. (4) The liner is then pulled, using cable-tool stem, jars, and spear (little difficulty has been experienced in pulling liners). (5) The open hole is then bailed clean of sand and mud, using dart-bottom bailer and sand-pump. (6) A 1-ft. length of 1½-in. wire line is then threaded through and wedged in a horizontal hole drilled through a cable-tool bit. This device is run to bottom on jars and stem and stroked up and down the entire open hole by rocking the beam and raising and lowering tools. (7) When the open hole has become "logy" with caving, tools are removed and the hole is cleaned out to bottom with a sand-pump. (8) A longer line is then wedged in the bit and the process repeated up to 4 ft. long, until a satisfactory cavity is created. (9) When a sufficiently large cavity has been created and cleaned out, gravel is merely poured into the casing in batches of 5–19 cu. ft. Oil is sometimes allowed to flow into the casing in small quantities while gravel is being poured, to prevent undue breakage of pebbles on casing joints. A measuring line or bailer is run after each batch of gravel, to ascertain the rate of fill and the shape of the cavity. Use of a bailer for this purpose allows some tamping and levelling of gravel in the cavity. The amount of gravel placed varies from 1½ to 5 yds., the average being 3 yds. (10) When the open hole and 2 ft. of casing are filled with gravel, a liner with "orange peel" point, and protecting baffle on bottom, perforated from bottom up high enough to reach within 2 ft. of the casing shoe, and with drive-head or pin coupling on top, is run-in on cable-tool pin that supports liner driver, jars, and stem. (11) The liner is driven through the gravel to total depth, this operation usually requiring from ½ hr. to 6 hrs.' jarring, depending on the size of the cavity obtained. (12) When the liner is on bottom and checked with a measuring line, the inside of it is bailed clear of broken-up gravel and settled sand and the well put back on the pump in the usual manner.

The results of 199 tests represent an immediate increase of 143% and a settled increase of 93% over the total potential immediately before gravel-packing. Some operators with relatively large numbers of completed jobs show an immediate increase of as much as 230% and a settled increase of 203% over the potential immediately before the work-over.

Costs and other items are discussed. A. H. N.

618.* Bottom-Hole Pressure Conditions Simulated in Flow Valve Test Rack. G. M. Wilson. *Oil Wkly*, 20.4.42, **105** (7), 17.—The paper described a method of determining the exact pressure differential under actual well conditions at which a particular valve will operate. A simple pressure-chamber, in which is placed the flow-valve, was

mounted on a heavy steel rack and connected up with high-pressure gas from a field line. By manipulation of several valves and checking pressure gauges and a manometer, actual bottom-hole pressure and flowing conditions may be observed while the valve operates. From the information thus gained, the valve may be adjusted at the surface before the tubing string is lowered in the well, thus obviating the necessity of making several trial-and-error settings before the valves are exactly adjusted to the conditions of a particular well.

The pressure chamber essentially is a short section of an oil-well, complete with casing and tubing. The lower section of the casing is removable, to allow the flow-valve to be screwed on to the tubing. Through outside controls, high-pressure gas may be injected into or released from the tubing and/or casing, simulating the exact pressure or flow conditions found at depth in a well.

The construction and operation of the apparatus are described and illustrated.

Each flow-valve to be run into a well is tested in this device before being made up in the tubing string. Any necessary adjustments in the kick-off pressure settings can be made with the assurance that they will conform to the conditions that by computation and experience are expected at that depth in the well. Similarly, whenever a string of flow-valves is removed from a well the valves are tested individually to determine if they were operating the same way at the end of the period as when originally run in the hole. This procedure yields a constant check on the performance of each make of valve which may be used. On valves that have been removed due to poor operating results it also indicates whether a valve failure has occurred or changes in well conditions have taken place.

Other principal purposes of the test-rack include detection of valve leaks in new and reconditioned valves, as well as in valves being taken out of service; changing valve differential settings by varying spring tensions; and varying the valve-port diameter in order to permit the passage of optimum volumes for the operating conditions.

A. H. N.

619.* Standardization Tests for Condensate Well-Sampling Devices. E. Sterrett. *Oil Wkly*, 27.4.42, **105** (8), 18.—With a view to establishing basic data on which sampling devices for measuring flow of gas-condensate wells may be rated, the Natural Gasoline Association of America has initiated and is sponsoring a series of tests on condensate wells of varying liquid content and pressure ranges in which the various sampling devices are checked against full, calibrated well-flow.

Testing of condensate wells is done by one or two general methods: (1) Full-scale tests involving measurement and sampling of the entire well production. This is expensive in outlay and personnel required to obtain an accurate measure of well capacity, but serves as guide or master control against which accuracy of all other methods is checked. (2) Small-scale testing, in which a relatively small representative portion of the well affluent is withdrawn from the flow-stream and examined.

Over half a dozen sampling devices are in use in various areas, and in quantities ranging from single units in the hands of their developers to multiple installations with wide distribution. Most of these units are variations on the principle of a small tube inserted into the flow-stream of the well. An equal or even greater number of devices and test methods is being used for evaluating the sample, nearly all of which involve separation at some pressure suitable to the individual operator, with or without examination of the separated gas at the option of the operator.

Gas volumes handled in these tests vary from around 20 cu. ft. up to several hundred feet, depending on the method being employed and the operator's views on the subject.

The flow-stream of practically all condensate wells contains retrograded liquid. The amount varies widely, as it is a function of the reservoir fluid and reservoir temperatures and pressures and surface temperatures and pressures. As surface temperatures can vary widely with changes in flow-rates, the relative amount of retrograded liquid is entrained as a finely divided mist, and a part of this liquid collects and flows along the walls of the tubing as a liquid film, flow being uniform or by heads, depending on the interrelation of wellhead factors. No sampling tube in the centre of the stream is able to sample this film liquid. Several of the devices now in use atomize the entrained liquid into an entrained mist, and then, through a sampling tube located at the optimum point, obtain a representative sample.

A series of tests is described in detail, and the paper is freely illustrated with photographs of a number of different types of apparatus and methods. A. H. N.

620.* A Practical Example in Unitization and Repressuring. J. E. Howell. *Oil Wkly*, 27.4.42, **105** (8), 28. *Paper Presented before Interstate Oil Compact Commission.*—The Shuler field of Union County, Arkansas, is a practical example of the benefits to be derived through the combination of unitization and repressuring. A tremendous gas waste has been eliminated, high gas–oil ratios reduced, sharply declining bottom-hole pressures have been checked, the flowing life of wells extended materially, and an additional recovery of 20 million barrels of oil is anticipated, after which approximately 23 billion cu. ft. of gas will be available for industrial and domestic markets. The field and its development are described.

Immediately upon starting operations as a unit, all wells producing large volumes of gas were shut in, and allowable production obtained only from wells of low gas–oil ratios. The result was a reduction in the average ratio of from more than 3000 cu. ft. to a barrel of oil to approximately 1400 cu. ft. to one barrel. This action alone reduced the decline in bottom-hole pressure from 1·6 lb./day to 0·5 lb./day. This improvement resulted in preventing a tremendous waste of gas and reservoir energy during the period of design and construction of a plant for the reinjection of the gas produced from the Jones sand back into that formation. The compressor plant is described.

The decline in bottom-hole pressure is less than 5 lb./month, and with the addition of gas planned to be collected from other sands producing in the field, and returned to the formation, this decline in pressure will be further retarded or eliminated. The results of the pressure-maintenance programme indicate that an additional recovery of 20 million barrels of oil will be obtained. After the production of oil ceases the reservoir will contain approximately 23 billion cu. ft. of gas available for use in industrial and domestic markets.

In keeping with the sound operating practice of maintaining the producing gas–oil ratio for the pool at a minimum, allowable production is taken from those wells having the lowest gas–oil ratios. This has resulted in the using of no more than fifty of the 146 wells at any one time. This in turn resulted in further agreements to unitize the upper horizons in the area with further success and saving. A. H. N.

621.* Paraffin Clogged Lines and Tanks Kept Open by Portable Boiler. G. M. Wilson. *Oil Wkly*, 27.4.42, **105** (8), 15–16.—Steaming out paraffin-clogged and constricted lead lines, tank batteries, separators, and numerous other important jobs around large leases is being easily and quickly done by one major company operating in West Texas, with the aid of a shop-assembled small portable boiler.

Following the spotting of the boiler at one of the centralized tank batteries in the morning, it is not uncommon to have the lead lines of eight wells cleaned out, the sludge and paraffin melted and drained out of the two tanks, and the header, separator cleaned out, all within an eight-hour tour. In addition, a small all-metal dog-house towed behind the boiler provides heat and shelter to the two men while they are on the job. When the boiler unit is moved, this is converted into a handy tool-house, in which are carried wrenches, fittings, and the flexible hoses that connect the boiler into the gas and water outlets at the tank location. The boiler and method of its use are described.

While the boiler unit was designed primarily for steaming lines and tanks, it has since fitted admirably into several other important jobs around the lease. It often happens, for example, that in bringing in a new well, a tank of dirty oil will be obtained which, unless processed with a chemical treatment, would not be pipe-line oil. With the aid of a heat exchanger and a portable circulating pump used in conjunction with the boiler, the oil can be heated and cleaned up to pipe-line condition. A. H. N.

622. Scale Removed from Pipe by Simple Treatment. H. F. Simons. *Oil Gas J.*, 16.4.42, **40** (49), 29.—The paper deals mainly with the problems met in pipes carrying salt water for disposal purposes. The scale deposition on the inside of pipes and tubing used in the disposal system is often so bad that these lines have to be taken up and the tubular material discarded or milled out. From a cost standpoint this is frequently prohibitive. However, a system designed to carry so many barrels/day will not

function properly when the diameter of the pipe and tubing is reduced substantially through an accumulation of scale.

There is also the possibility in some cases, and an actual occurrence in many, that scale will be deposited in the pores of the disposal zone and plug it. The reverse often happens in pumping wells where subsurface pumps frequently become clogged so badly with scale that they will not operate. Examples are quoted in detail.

Scale deposited by salt water in producing wells, lines, and in salt-water disposal systems is due to three general causes. These are (1) calcium supersaturation of the brine due to change in equilibrium and precipitation of the excess material, (2) mixture of brines from different sources, which causes precipitation of previously dissolved components, and (3) the presence of dissolved iron in the brine which will precipitate if it is exposed to the atmosphere.

The mixture of sodium hexametaphosphate and alkaline quebracho tannin will effectively prevent carbonate precipitation and also the deposition of sulphates of calcium, strontium, and barium. It will suspend four parts of iron in solution for each part of sodium hexametaphosphate present. Corrosion is also retarded. The sodium hexametaphosphate–quebracho treatment has been used with much success for preventing scale formation in cooling systems. The sodium hexametaphosphate possesses several properties which make it particularly suited for eliminating scale or preventing its deposition. It has the ability to combine with many multivalent cations, thereby increasing their solubility; it has definite surface-acting properties, and it is absorbed by metal surfaces. Alkaline quebracho tannin also possesses the property of preventing the deposition of scale.

Cost of the chemical for the treatment is quite low, ranging from 0·3 to 0·6 mills/brl. of salt water. Experimental results are reported. A. H. N.

623. Design of Gun-Barrel Tanks for Oil–Water Separation. F. B. Gordon. *Oil Gas J.*, 23.4.42, **40** (50), 71.—The primary purpose of the gun-barrel is to separate water from oil, hence it is sometimes referred to as a settling tank. The separation is effected by the difference in density and mutual insolubility of water and oil. In nearly all cases the process is continuous. Therefore the accumulating water and oil must be removed. The removal of the water takes place at the water-drain, somewhere near the bottom of the tank. The oil passes out through a fixed overflow connection. For proper operation, the water level in the gun-barrel should remain constant. In practice, the water level is controlled by an adjustable gooseneck overflow or siphon. The water overflow is sometimes called a grasshopper. The dimensions and settling of the grasshopper determine the water level in the gun-barrel.

The principles of design are given briefly, in conjunction with illustrations.

A. H. N.

624.* Salt Water Disposal System Utilizes Non-Corrosive Materials. C. C. Pryor. *Petrol. Engr*, April 1942, **13** (7), 42.—One of the major companies operating in eastern Texas fields has designed and placed in operation a salt-water system that is regarded as being most successful from several standpoints.

As the company decided upon a policy of returning the salt water to a formation approximately 300 ft. below the main producing zones and outside the producing area of the field, it was necessary to adopt a method of gathering the salt water from the various leases throughout the field. To accomplish this purpose, concrete pits were constructed at strategic points, into which the salt water was collected from a certain number of leases. The leases were selected so that their total production of salt water could be easily handled by the pits. The construction and other details of the pits are described.

It had been the practice of the company to purchase large quantities of chlorine for treating the water in these collecting pits before it was conducted by gathering lines to the final treating-pit. In the present emergency War Production Board restrictions have resulted in the manufacturer being unable to deliver the required chlorine. As it was essential that the water be sterilized before entering the pipe-line to the final treating-pit, it was decided to manufacture the required product. The equipment used is described and illustrated.

The special salt-water pumps used are studied. These consist of an 11-stage turbine assembly with approximately 3 ft. of 3-in. discharge column, a surface-type discharge

head, and a 5-h.p., 3-phase, vertical hollow-shaft motor. The pumps were designed for a capacity of 60 gal./min. against a head of 185 ft. with an efficiency of about 83%. Construction of these pumps is such that there are no metal-to-metal contacts between the rotating shaft and impellers and the stationary bowls. Similar metals are used in so far as it is practicable.

The gathering system and the treatment of the water to remove iron oxide by aeration are finally discussed, together with filtering arrangements used. Leaving the filters, the water is metered, and passes through a regulator that holds back-pressure on the filters, keeping them full of water, as the vacuum on the wellhead would drain the water out and allow them to dry.

There is a vacuum of approximately 30 in. of mercury at the wellhead. The well tubing is 5-in. O.D., cement-lined, with the bottom end opened and a packer set above the formation in the 7-in. casing. A. H. N.

625.* Subsurface Disposal of Oilfield Brines in Oklahoma. S. S. Taylor and E. O. Owens. *U.S. Bur. Mines, Rep. Invest.* 3603, January 1942.—As a method of oilfield brine disposal, subsurface injection has been practised in many oil-producing areas in Oklahoma and elsewhere. The technique, which has been vastly improved since its inception in 1925, offers many advantages over other systems of brine disposal—*e.g.*, impounding and solar evaporation, controlled diversion into surface waters, and recovery of the mineral salts of the brine, and, in fact, eliminates the damaging effects of mineralized water on freshwater supplies, vegetation and aquatic, and other animal life.

This report embodies the results of a study by the Bureau of Mines of three disposal systems in Oklahoma, designed to take care of brine produced from approximately 1000 oil-wells.

Conclusions reached are that for effective and economic subsurface disposal schemes, deep-seated permeable strata are desirable. Otherwise it becomes necessary to employ relatively high surface pressures. To avoid plugging of the disposal formation, the brine injected should be conditioned so that no suspended solids reach or are precipitated in the disposal formation. If the brine is found to be corrosive to iron or steel, the use of corrosion-resistant equipment between the filters and the disposal formation will facilitate the operation if the brine has been adequately conditioned.

It was found with the particular brines studied in this report that stabilization or removal of the iron compounds was the most important chemical change necessary in preparing the brine for subsurface disposal. Other types, however, may contain unstable bicarbonate compounds or soluble iron compounds requiring special treatment.

In cases where extensive gathering lines are used and the brine flowing through them to the conditioning plant is exposed to and agitated in the presence of atmospheric oxygen, due consideration must be given to the probable change which may occur in chemical characteristics of the brine during transportation before finalizing design and capacity of the brine-treating equipment. H. B. M.

626.* Use of Hot Distillate to Remove Paraffin from Sand Face. T. P. Sanders. *Oil Gas J.*, 9.4.42, **40** (48), 37.—This method supplies both heat and solvent in one operation through a system of washing the bottom of the well with a hot distillate. At present the work employs no special equipment that was not on hand at the leases prior to the first trial, but it is quite likely that the washing treatment could be improved and streamlined through the use of special portable units.

The 100-brl. charge of distillate is heated to about 190° F. before being introduced into the well. Attempts to obtain higher temperatures with low-pressure steam passing through the coils have seldom been successful, because too much time is required, resulting in a correspondingly large loss of vapour from the distillate.

The hot distillate is not dumped down the casing, because heat loss would thereby be too great. Instead, the sucker rods are raised to unseat the plunger and the standing valve so that the hot fluid can be introduced down the tubing. No transfer pump is used, since there is ordinarily very little fluid in this type of well that requires treatment, and the 100-brl. tank is therefore rapidly emptied by gravity flow into the well.

Within about 15 minutes after the hot solvent has been placed, the well is put back on the beam. This requires reseating the standing valve, after which the entire charge of distillate is pumped out of the well and back into the 100-brl. tank. The temperature drop of the solvent is then noted, and steam is again turned into the coil. When the charge has been reheated to 190° it is again sent down the tubing. This washing cycle is repeated three times.

On returning to the surface after the third cycle, the "distillate" is usually about 50% crude oil and paraffin. At this point it is sent through the lead line to the tank battery to be sold with the lease production. Bought as distillate at 4½ cents/gal. ($1·89 per brl.), it is sold as crude oil at $1·20 per brl. so that comparatively little is lost in the exchange. Pampa crude normally averages 42–43° gravity, and since 40-gravity crude brings top price, no monetary benefit is derived from the distillate on the basis of gravity increase. This would not be the case in all fields, however, and in localities where the increase in gravity meant additional revenue from oil sales the added sum would serve to reduce the cost of treatment. A. H. N.

627.* Economic Use of Electric Power in Petroleum Production. W. H. Stueve. *Oil Gas J.*, 9.4.42, **40** (48), 38.—In a relatively small area of some 7 sq. miles surrounding the town of St. Louis, in Pottawatomie County, Oklahoma, the oil producers have been using electric-motor-driven submerged centrifugal pumps for 8 years, from 1934 to date, to produce oil profitably from certain wells which, had it not been possible to secure this type of equipment, would doubtless have been abandoned.

In summarizing the 8-year record of operations of the submerged centrifugal pumps in use in the St. Louis field of Oklahoma, the following conclusions are reached: (1) With an average investment of approximately $340,000 (thirty-four pumps) during the 8 years studied, a gross revenue of about $12 million has been achieved before royalty payments and production taxes. (2) With a net revenue from oil produced of about $10 million during the period studied, after allowances are made for repairs of $1,160,000 and an estimated cost of electric power of $2,085,000, there remains a balance of $6¾ million from which the other costs and the profit on the operations are obtained. (3) With an average lifting depth of 4000 ft. and a composite specific gravity of 1·18 for the total liquid pumped during the period studied, a resultant overall efficiency of 48% is obtained from electric metered energy to fluid delivered at the ground surface tank battery. A. H. N.

628.* Usefulness of Sucker Rods Prolonged by Proper Care at the Well. J. C. Albright. *Petrol. Engr*, April 1942, **13** (7), 72.—In a short paper the extra life imparted to sucker rods by using proper stands on which to lay the rods being pulled from a well is stressed. In recent months many operators have abandoned the use of wooden rod-troughs, and have devised metal stands on which the rods are laid. These stands are generally made of material that permits quick and ready movement from the ground to the pulling machine or truck, and likewise can be strung out at the well with little delay. One set usually suffices for as many wells as one pulling machine can service. These metal stands are portable, are easy to wipe clean when oil drips from the rods, and provide no fire hazard. The older wooden troughs represented a considerable investment, and the material from which they were constructed could not be utilized for another purpose once they were built and had become soaked with oil and crusted with drifting sand and dust.

The method of constructing these stands is discussed. A. H. N.

629. Patents on Production. H. R. Downs. U.S.P. 2,277,746, 31.3.42. Appl. 20.3.39. Fluid regulator for use with a fluid motor adapted to operate against a variable back pressure.

T. A. Andrew. U.S.P. 2,277,898, 31.3.42. Appl. 26.4.40. Means for measuring flow in wells.

R. F. McMurray. U.S.P. 2,277,922, 31.3.42. Appl. 29.7.39. High-pressure slip coupling.

A. S. Parks. U.S.P. 2,278,017, 31.3.42. Appl. 22.5.39. Flow apparatus for wells using tubing.

M. De Groote and B. Keiser. U.S.P. 2,278,164, 31.3.42. Appl. 25.1.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,278,165, 31.3.42. Appl. 25.1.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,278,166, 31.3.42. Appl. 25.1.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,278,167, 31.3.42. Appl. 25.1.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,278,168, 31.3.42. Appl. 25.1.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,278,169, 31.3.42. Appl. 25.1.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,278,170, 31.3.42. Appl. 25.1.41. Process for breaking petroleum emulsions.

M. De Groote and B. Keiser. U.S.P. 2,278,171, 31.3.42. Appl. 25.1.41. Process for breaking petroleum emulsions.

J. H. Wiggins. U.S.P. 2,278,294, 31.3.42. Appl. 11.3.40. Drainage means for tank roofs.

J. O. Wilson. U.S.P. 2,278,296, 31.3.42. Appl. 24.7.41. Rotator attachment for pumping-jacks.

C. E. Bridwell. U.S.P. 2,278,399, 31.3.42. Appl. 2.1.40. Pumping mechanism with stationary tubular plunger and reciprocating barrel.

A. Boynton. U.S.P. 2,280,785, 28.4.42. Appl. 4.10.38. Well-testing tool using packers.

A. Boynton. U.S.P. 2,280,787, 28.4.42. Appl. 8.12.39. Differential stage-lift flow device.

A. Boynton. U.S.P. 2,280,788, 28.4.42. Appl. 8.12.39. Flow device for oil-wells using gas-lift.

W. H. Hazard. U.S.P. 2,280,910, 28.4.42. Appl. 30.10.39. Lubricating means for the power mechanism of a deep-well pump.

G. C. MacDonald. U.S.P. 2,281,103, 28.4.42. Appl. 3.11.39. Apparatus for placing explosives in a well under positive control from the top of the well.

C. E. Records. U.S.P. 2,281,326, 28.4.42. Appl. 15.8.40. Well-screen.

A. H. N.

Transport and Storage.

630.* The Amount and Measurement of Internal Corrosion in Gasoline Pipelines. J. M. Pearson. *Oil Gas J.*, 6.11.41, **40** (26), 169.—The method of inserting steel samples into the line to measure internal corrosion is open to several objections detailed, and fails to evaluate the unknown effect of scraping. Since experience shows the corrosion is general and pitting of the metal presents a relatively low profile, measurement of weight loss directly on the pipe-wall should provide useful data, and two types of experiments with this object in view are in progress. In both cases the weight of pipe is determined from careful measurements of pipe resistance and temperature. The electrical circuits and connections required are described and illustrated. In one experiment quarter sections of pipe joints were cleaned, machined, measured, and weighed, and then welded into a trunk line, the outside being protected by a box filled with asphalt, to obviate external corrosion. For reweighing by electrical methods, pipe had to be removed and re-machined before replacement, and the short lengths

necessitated very accurate measurements. In the second experiment a longer section of pipe was used, and electrical connections and a thermometer well were provided to permit measurements to be made *in situ*. The entire section, together with insulating joint to eliminate stray currents which might interfere with readings, is enclosed in a box filled with asphalt, thus extending the insulation provided by the joint to include the entire electrical circuit, as well as eliminating external corrosion. A sample of the actual pipe used is taken, so that variation of resistance with temperature can be measured and the results used as basis for estimating loss in weight of the test pipe in service from the resistance and temperature determinations. Present data are insufficient to enable final conclusions to be reached, but indicate : (1) Rate of corrosion is higher in proportion to the amount of moisture and oxygen introduced. (2) Rate of corrosion is highest at the point of introduction of these elements, falling sharply at more remote points. (3) Depending on pumping rates and location, weight-loss rates of corrosion vary from 0·1% to 2% of the pipe-wall per annum. (4) There is some evidence that scrapers increase the average rate of corrosion. (5) As regards life expectancy of lines, soil corrosion and other external factors deserve first consideration. R. A. E.

631.* Experience With and the Effect of Use of Scrapers on Internal Corrosion of Gasoline Pipe-lines. D. E. Sullivan. *Oil Gas J.*, 6.11.41, **40** (26), 122.—It has been found by experience that the capacity of a gasoline pipe-line declines unless steps are taken to combat internal corrosion, considered to be due to precipitation of water from the gasoline by reduction in temperature. In some cases the building up of corrosion products in sharp bends or around interior recesses of valves completely plugged the lines, and in others barnacle-like structures adhering to the inside of the pipe increased resistance to flow. It was found that conventional type scrapers as used on crude oil and water lines were not efficient in removing water and corrosion products from gasoline lines, and also gave rise to operational difficulties.

A scraper which has been found satisfactory for the purpose consists of a short, plug-like scraper made up of a series of six natural rubber discs and five circular wire brushes suitably mounted on a 14-in. length of extra strong pipe, plugged at both ends. The brushes are double-knot wire brush-wheels 1 in. thick, made of 0·014-in. piano wire, and having a diameter of 6½ in. for use on a 6-in. line. They scrape the products of corrosion free from the walls of the pipe. The rubber discs are prepared from a natural rubber compound partly soluble in gasoline and expanding 25–50% in volume when immersed in gasoline for 12 hrs. The squeegee effect of the discs tends to wipe off water which adheres to the pipe walls, and the swelling of the rubber in contact with gasoline helps to counteract the effects of wear in use, so that the scraper can be used for about 120 miles of line before becoming unserviceable. Recommendations for use as a result of experience are : (1) Use scrapers in pairs with a 15–20 min. interval between. (2) Instal at each pit where scrapers are removed from the line a slop-tank of sufficient capacity to deal with discharge from the line during a period 5 mins. before arrival of scraper and 10 mins. afterwards. Most of the debris and water are collected during this period, and the use of the slop-tank avoids deposition in strainers or delivery tanks. (3) The use of scrapers at uniform intervals of 3–4 days will avoid risk of line-plugging due to piling up of debris ahead of the scraper. Experience on a 6-in. line 80 miles in length showed a decline in line capacity to 74% of the original over a period of 2½ years' operation. The relationship between scraper usage and capacity during the succeeding 5 years is illustrated graphically, and at the end of the period usage at the recommended rate had restored capacity to slightly over 100%. The effect of the scrapers on the actual rate of interior corrosion of the line is not known. Methods of insertion and removal are described and illustrated.
R. A. E.

Crude Petroleum.

632.* Characteristics of California Crude Oils. R. C. Mithoff, G. R. MacPherson, and F. Sipos. *Oil Gas J.*, 6.11.41, **40** (26), 81. (*Paper presented before American Petroleum Institute.*)—Owing to the wide variations in properties of crude oils produced in California, the Standard of California has developed special methods of analysis, which are described and illustrated. Three analytical distillation methods which are used as required are :—

(1) Yields of gasoline, kerosine, gas oil, and residue of defined qualities are obtained by distillation from a 5-litre flask of stainless steel equipped with a 29-in. column of special design and conventional analyses of the products made to ascertain their principal properties. (2) True boiling-point distillations are carried out in an apparatus of special design, and 4% cuts obtained by successive distillation to 635° F., (*a*) under atmospheric pressure, (*b*) under pressure of 10 mm., (*c*) under pressure of 1 mm. The cuts are examined for gravity, sulphur content, viscosity, neutralization number, pour point, aniline point, and mol. wt., and a measure of paraffinicity is obtained by determination of characterization gravity, the arithmetic average of instantaneous gravities of distillates boiling at 350° F., 450° F., and 550° F. vapour line temperature at 25 mm. pressure. (3) Analyses are carried out on heart-cuts prepared by blending fractions of narrow boiling range obtained by distillation of 15 gals. of crude in a 20-gal. still fitted with an efficient column, and with provision for applying steam and vacuum. Results may be plotted on charts which show the particular quality as a function of percentage distillate from the crude oil at the start and end of the desired distillate, and yield/quality curves may also be obtained.

No truly satisfactory method is available for grouping or classifying California crude oils among themselves. However, broadly speaking: (1) Most of the more naphthenic oils (characterization grav. 23° or lower) are of 27° A.P.I. grav. or heavier, whereas oils of 28° A.P.I. grav. or lighter (characterization grav. 26–30°) are relatively paraffinic. (2) Most oils of high sulphur content are heavier than 20° A.P.I. grav., but sulphur content bears little relationship to paraffinicity, as many relatively heavy oils are of low sulphur content. (3) Relation to geological age appears general, deep wells from geologically older strata usually yielding lighter, more paraffinic oils of lower sulphur content than shallower wells in the same field.

From the results of numerous analyses of California crude oils the following conclusions are reached: (1) A.P.I. grav. range is from about 6° to 60°. (2) Gasoline yield nil to 85% (390° F. E.P.). (3) General trend for gasoline content to increase with rising A.P.I. grav., but yield variation for given A.P.I. grav. is great. (4) Sulphur contents range from 0·1% to 6·0% (normally 0·3–1·5%), but the oils are relatively free of H_2S and mercaptans. The sulphur compounds are more stable to heat than those present in most crude oils, and tend to produce less H_2S on distillation at low pressures. Distillates are, however, relatively high in total sulphur content, and on cracking residuum the sulphur compounds tend to split into compounds of intermediate boiling range which appear in the naphtha. Cracking of Californian stocks also results in considerable H_2S and mercaptan formation, and gives rise to considerable corrosion of equipment, necessitating the use of special steels for tubes, lines, and vessels. (5) The naphthenic character of the oils is reflected in the relatively high octane ratings of the straight-run, cracked, and reformed gasolines obtained. (6) Wax contents of the relatively paraffinic types normally range from 2% to 4%, and the wax is concentrated in the heavy gas oil and lubricating oil distillates. (7) Naphthenic acids occur throughout the boiling range from kerosine to asphalt, and considerable amounts are recovered from the distillates. (8) Cracked naphthas contain considerable amounts of nitrogen bases and phenolic compounds which can be recovered.

As regards straight-run products from Californian crudes, gasolines usually require acid treatment to meet colour requirements, and sometimes to lower sulphur content and pass the doctor test; kerosines require SO_2 treatment to produce high-grade burning oils; high-grade lubricants are normally prepared by solvent treatment and dewaxing of distillates from waxy crudes; the heavy fuels produced by straight distillation or cracking usually require blending with 10–20% of light gas oil to meet viscosity and gravity requirements.

Good yields of high-octane-rating gasolines are obtained by reforming Californian naphthas, but treatment is needed to meet colour and colour stability requirements. Residue is usually employed as cracking stock, and results show that yields of gasoline obtainable can be satisfactorily related to viscosity of stock for Californian oils, and a viscosity/yield chart is presented. Other charts relate sulphur content of cracked naphtha to that of charging stock and octane number of cracked gasoline to characterization gravity of charging stock for single-coil units equipped with reaction chambers.

Comparison is made with Eastern and other crude oils as regards characteristics, refinery treatment, and yields. R. A. E.

Cracking.

633. Patents on Cracking. G. C. Connolly. U.S.P. 2,275,176, 3.3.42. Appl. 6.12.38. Method of cracking hydrocarbon oils which involves subjecting the oil at cracking temperature to the action of a synthetic silica–alumina gel catalyst containing a minor portion of alumina and not more than 1% of tin oxide.

E. H. McGrew. U.S.P. 2,276,081, 10.3.42. Appl. 12.8.39. Method of combining hydrocarbon oil heavier than gasoline with hydrocarbons in the gasoline boiling range. The resultant mixture is subjected to the action of a cracking catalyst at a temperature between 600° and 900° F. Gasoline is separated from insufficiently converted oil, and at least a portion of the latter catalytically cracked at a higher temperature to convert a substantial portion into gasoline. The heavier fractions of the gasoline are combined with the hydrocarbon oil.

N. K. Chaney. U.S.P. 2,276,288, 17.3.42. Appl. 19.10.38. Production of manufactured gas and valuable hydrocarbons by the thermal cracking of fluid hydrocarbons in vapour phase. Firstly, a heated path is established, and the fluid hydrocarbons passed along it and cracked. A portion of the moderately cracked products is then withdrawn and exposed to severe cracking conditions to form reactive radicals. Afterwards the products are returned to the path for reaction with the unwithdrawn products.

K. M. Watson. U.S.P. 2,278,228, 31.3.42. Appl. 13.5.40. Conversion of hydrocarbon oil into substantial yields of high anti-knock gasoline by adding to the oil a powdered cracking catalyst in amount substantially less than that maintained in a subsequent reaction. The mixture is subjected to catalytic cracking conditions of temperature, and at a pressure adequate to maintain a substantial portion of oil boiling above the gasoline range in liquid phase. The vaporous fraction is removed, and gasoline and gas are recovered. A portion of liquid reactants is withdrawn from the reaction zone to a separating zone and subjected to gravity settling. In this way the catalyst is substantially removed from a part of the reactants. A portion of the remaining oil from the settling zone is returned to the reaction zone to build up and maintain a higher concentration of catalyst in the zone than is added to the hydrocarbon oil. H. B. M.

Hydrogenation.

634. Patents on Hydrogenation. Universal Oil Products Co. E.P. 544,127, 30.3.42. Appl. 3.4.40. A two-stage process for the production of butadiene from normal butane. The first stage involves the dehydrogenation of butane to normal butenes, and the second a further dehydrogenation of separated butenes to butadienes under altered and optimum conditions.

E. N. Hague. U.S.P. 2,275,178, 3.3.42. Appl. 11.5.39. Process for recovering *iso*-octane from excess hydrogen-containing gas used in the hydrogenation of *iso*-octenes to *iso*-octanes. The excess gas containing *iso*-octane vapours is contacted with an absorption oil comprising polymers boiling in the range 300–400° F. Thereafter the used absorption oil is distilled to separate from it the absorbed *iso*-octane.

V. N. Ipatieff and B. B. Corson. U.S.P. 2,275,181, 3.3.42. Appl. 3.4.39. Conversion of olefinic and aromatic hydrocarbons into more saturated hydrocarbons by subjecting the initial material to hydrogenation in the presence of metallic copper and iron oxide. H. B. M.

Polymerization and Alkylation.

635. Patents on Polymerization and Alkylation. Standard Oil Development Co. E.P. 543,420, 25.2.42. Appl. 11.12.39. Improved method of preparing non-asphaltic linear type polymers of high molecular weight by polymerization of *iso*-olefins with a metallic halide Friedel–Crafts catalyst at a temperature below −10° F. When the desired viscosity has been reached an alkaline substance is added to the reaction mass, and improved polymerization products are obtained by contacting the products of this process with the alkaline substance before the temperature is allowed to rise above −10° F.

W. M. Smyers. U.S.P. 2,274,749, 3.3.42. Appl. 17.7.37. Preparation of a copolymer having a molecular weight above 1500 by polymerizing at a temperature

below 0° C. in the presence of an active halide catalyst a mixture of an aliphatic olefine having more than two carbon atoms, and a different reactive mono-olefinic hydrocarbon capable of polymerization and containing a cyclic nucleus. These materials are the only reactants.

J. C. Morrell. U.S.P. 2,276,250, 10.3.42. Appl. 29.2.40. Production of hydrocarbons boiling within the gasoline range from *iso*paraffin and olefin hydrocarbons by simultaneously contacting an *iso*paraffin and an olefin at an alkylating temperature with sulphuric acid to which has been added an inorganic, oxygen-containing boron compound. The amount and concentration of the acid, the reaction temperature, and the proportion of olefin to *iso*paraffin are correlated to effect alkylation of the *iso*paraffin, with minimum olefin polymerization. In this way the *iso*paraffin and olefin hydrocarbons are chemically combined to form a heavier hydrocarbon boiling in the gasoline range.

J. C. Morrell. U.S.P. 2,276,251, 10.3.42. Appl. 29.2.40. Production of hydrocarbons boiling within the gasoline boiling range in a manner similar to that described in U.S.P. 2,276,250 above, except that an organic base is added to the sulphuric acid instead of an inorganic oxygen-containing boron compound.

P. Subkow. U.S.P. 2,277,938, 31.3.42. Appl. 12.7.38. Production of reformed and polymer gasoline by heating at a gasoline reforming temperature in a series of coils in a restricted stream and without separation of vapours, a slurry of comminuted catalyst and petroleum hydrocarbons having an end-point not exceeding 650° F., and containing gasoline fractions. H. B. M.

Refining and Refinery Plant.

636.* World-Oil-Refineries Survey. Anon. *Oil Gas J.*, 25.12.41, **40** (33), 107.—A list of refineries outside U.S.A. is given, and is arranged alphabetically according to country and name of operating company. Details include plant location, name of superintendent, crude capacity, type of refinery, cracking capacity and type of plant, and operating status.

Pre-war totals only are shown in the case of countries which have been at war since the latter part of 1939. R. A. E.

637.* Argentina Expands Refining Facilities. Anon. *Oil Gas J.*, 25.12.41, **40** (33), 96.—Two new refineries have been erected near producing centres with the main objective of supplying surrounding territories and reducing long transportation previously needed. One refinery situated at Lujan de Cuyo in the Province of Mendoza has a daily crude capacity of 3150 brls., is equipped for primary distillation, viscosity reduction, and selective cracking of gas oil, and operates on Tupungato crude. Estimated annual output in brls. is: motor fuel 598,500, kerosine 81,900, fuel and diesel 314,000. The other refinery is at Salta City, and has a daily crude capacity of 1890 brls. Estimated annual output in brls. is: motor fuel 441,000, kerosine 18,900, fuel and diesel 132,000.

In addition, a viscosity-breaking unit was placed in operation at La Plata refinery during the year. This can handle 5000 brls. a day of heavy fuel viscosity S.F. at 122° F. 700–800 secs., producing fuel of viscosity S.F. at 122° F., about 200 secs., meeting Argentine Republic specification in this respect.

Crude runs to refineries in Argentine in 1941 are expected to amount to 27 million brls., whilst imports of petroleum products will be reduced to 10–12 million brls., 95% of which will be fuel oil and crude required to balance home production and consumption. R. A. E.

638.* Capacity of Uruguayan Refinery Increased 25 per cent. E. S. Pelufo. *Oil Gas J.*, 25.12.41, **40** (33), 89.—The capacity of the Ancap refinery has been increased from 5000 to 6300 brls. a day by installation of fuel to crude-heat exchangers and changes in the pumping arrangements. The octane rating of the motor gasoline has been improved slightly by installation of a catalytic-polymerization plant operating on gases from the cracking plant.

Crude charged to the plant during the past 12 months totalled 2,046,000 brls., about 75% of which was Peruvian and Ecuadorian paraffin-base type, and 25%

Temblador (Venezuelan) crude. The latter was treated in the topping plant only, but 40% bottoms from the former are charged to the cracking unit, which handled 650,000 brls. in the same period, and produced 50% gasoline and 42% fuel from the charging stock.

Quantities of the various grades of finished products produced are given.

R. A. E.

639. Patents on Refining and Refinery Plant. J. C. Morrell. U.S.P. 2,276,249, 10.3.42. Appl. 19.1.35. A process which involves topping crude petroleum containing straight-run gasoline to separate therefrom a light fraction containing gasoline boiling hydrocarbons. The topped crude is distilled to coke, and high-boiling products are separated from overhead products of the coking operation. The lighter components of the overhead products are combined with the light fraction from the crude petroleum, and the resultant mixture is passed through a heating coil and subjected to cracking conditions of temperature and pressure to increase the anti-knock value of the gasoline hydrocarbons. The resultant conversion products are cooled by indirect heat exchange, with crude oil being supplied to the topping operation in order to preheat the crude and separate heavy constituents of the conversion products. The separated heavy constituents are passed to the coking operation while the cooled conversion products are fractionated and condensed.

G. H. Von Fuchs and H. H. Zuidema. U.S.P. 2,276,526, 17.3.42. Appl. 3.4.39. Method of refining a hydrocarbon oil selected from the group consisting of lubricating and electrical oils free from asphalt containing harmful sulphur in the form of mercaptan sulphur. The oil is heated in liquid state at a temperature between 400° and 700° F., with at least 1 mol. of cuprous oxide per molecule of said mercaptans under non-oxidizing conditions, to convert mercaptan sulphur into cuprous sulphide and substantially to prevent conversion of mercaptans into disulphides. H. B. M.

Chemistry and Physics of Hydrocarbons.

640. Inflammability of Ether–Oxygen–Helium Mixtures: Their Application in Anæsthesia. G. W. Jones, R. E. Kennedy, and G. J. Thomas. *U.S. Bur. Mines, Rep. Invest.* 3589, October 1941.—It is pointed out in this report that helium adds certain very desirable characteristics to anæsthetic mixtures. It is one of the lightest gases known and, because of its low density, its addition to such mixtures enables them to permeate the spaces in the lungs at a higher rate and, therefore, more completely than other mixtures having a higher density. Owing to its almost perfect inertness and very low solubility in water and body-fluids, it exerts little, if any, physiological effect on the patient breathing it.

Its most outstanding advantage over other inert gases is the high rate at which it conducts heat and electricity, and for this reason it is considered to offer remarkable potentialities in the prevention of static ignition of inflammable anæsthetic mixtures.

In April 1939 a Sub-committee, including representatives of the Bureau of Mines, the University of Pittsburg School of Medicine, the American Society of Heating and Ventilating Engineers, etc., was appointed to study the hazards of gases and vapours used in anæsthesia, and this report represents the findings of that Committee. It was found that the oxygen content of ether–oxygen–helium mixtures must be kept below about 16% to eliminate explosion hazards. If strictly non-inflammable mixtures are demanded, the addition of helium to ether–oxygen mixtures presents certain difficulties. Nevertheless, under certain conditions it may be permissible to administer mixtures in which the inflammability is of a mild order, and such mixtures are considered far safer from the explosive point of view than those containing high percentages of oxygen.

Both *cyclo*propane and ether are often used together with oxygen in anæsthesia. The joint effect of two combustible anæsthetics having markedly different oxygen requirements and flame characteristics in combustion with helium is not at present known, but clinical experiments are now being investigated by the authors of this report. Although these experiments are not as yet complete, results so far have been very satisfactory, and indicate that the addition of 5% or more of ether to non-inflammable mixtures of *cyclo*propane–oxygen–helium mixtures in the upper limit range does not bring the mixtures back into the inflammable range. H. B. M.

Motor Fuels.

641. Patents on Motor Fuels. Kodak Ltd. E.P. 543,544, 3.3.42. Appl. 27.5.40. Stabilization of a liquid hydrocarbon motor fuel with N_1N^1-di-(secondary-alkyl)-*p*-phenylenediamine obtained by condensing a *p*-dihydric phenol of the benzene series with a secondary alkyl primary amine containing at least four carbon atoms, and separating from the product a fraction consisting essentially of N_1N^1-di-(secondary-alkyl)-*p*-phenylenediamine.

Standard Oil Development Co. E.P. 543,968, 23.3.42. Appl. 23.2.40. Process for increasing the octane number of a hydrocarbon oil. The oil is subjected to a temperature between 800° and 1100° F. under pressure in the presence of a catalyst and in the presence of a gas containing free hydrogen. The time of treatment is so adjusted in conjunction with temperature, pressure, and partial pressure of the hydrogen that there is no net consumption of free hydrogen. The reaction gases, including the normally gaseous products of the reaction, are recycled in whole or in part to supply the necessary hydrogen-containing gas.

Standard Oil Development Co. E.P. 543,970, 23.3.42. Appl. 13.6.40. Preparation of a motor fuel having an improved road octane rating by catalytically reforming the fractions of a cracked fuel boiling substantially between 192° and 325° F., or the fractions of a virgin naphtha boiling up to 325° F., in the absence of other fractions. The reformed fractions are blended with lighter and/or heavier hydrocarbons to produce a motor fuel having an end-point of about 425° F.

M. W. Kellogg Co. E.P. 544,155, 30.3.42. Appl. 27.9.40. Production of motor fuel having a high anti-knock value, a high percentage of naphthenic compounds, and substantially free of deleterious olefinic compounds from a naphtha fraction boiling within the gasoline range and consisting predominantly of aliphatic hydrocarbons.

Universal Oil Products Co. E.P. 544,336, 9.4.42. Appl. 27.10.39. Conversion of hydrocarbon oils of end boiling point higher than gasoline into large yields of motor fuel of high anti-knock value and substantial yields of normally gaseous, readily polymerizable olefins. The hydrocarbon oils are subjected at a temperature between 425° and 650° C. to contact with a catalytic material consisting of hydrated silica and hydrated zirconia substantially free from alkali metal compounds.

Standard Oil Company. E.P. 544,642, 22.4.42. Appl. 11.9.40. Method of converting a low-knock-rating naphtha into a high-knock-rating motor fuel by passing the former over a non-siliceous catalyst having dehydrogenation and ring-closing properties, in the presence of hydrogen at a temperature between 850° and 1075° F., and a pressure between atmospheric and 450 lb./sq. in., at a space velocity of 0·04–5 vol. of liquid naphtha per volume of catalyst per hour.

D. M. Clark. E.P. 544,729, 24.4.42. Appl. 11.2.41. Method of preparing a fuel composition consisting predominantly of normally fluid, readily inflammable hydrocarbons by adding to the hydrocarbons a sodium soap, not more than limitedly soluble therein, and adapted to congeal the same. Afterwards an organic solvent for the soap and the hydrocarbons is added in amount sufficient to bring them into solution. The solvent boils substantially below the major part of the hydrocarbons. The organic solvent is subsequently removed by distillation and the residual hydrocarbon soap mixture allowed to solidify.

G. H. Cloud. U.S.P. 2,275,175, 3.3.42. Appl. 30.11.39. Preparation of a high-compression spark-ignition motor fuel which consists of gasoline hydrocarbons blended with an octane-number improving amount of 2–15% by volume of a dialkyl phenol wherein a methyl group is one of the positions *ortho* and *meta* to the hydroxy group, and a branched-chain alkyl group containing 3–5 carbon atoms *para* to the hydroxy-group. The dialkyl phenol has a melting point below 40° F. and a boiling point within the range 395–475° F.

F. E. Frey. U.S.P. 2,275,377, 3.3.42. Appl. 2.4.40. Production of motor fuel having a low volatility and a high octane number by reacting alkylation paraffin hydrocarbons of from 3 to 6 carbon atoms per molecule, with olefin hydrocarbons to form paraffin hydrocarbons of a higher number of carbon atoms per molecule than the initial hydrocarbons and in the motor-fuel range. At least part of the effluent of this reaction is passed to the action of a dehydrogenation catalyst to improve the octane

number of motor-fuel hydrocarbons, and at the same time to produce olefins lower boiling than motor fuel. From the dehydrogenation effluent a fraction is separated which contains olefins lower boiling than motor fuel. The latter fraction is passed to the alkylation operation.

E. R. Kanhofer. U.S.P. 2,275,441, 10.3.42. Appl. 30.6.39. Production of motor fuel of high anti-knock value and relatively low olefin content by combining olefinic gasoline with a hydrocarbon oil heavier than gasoline and containing a substantial proportion of saturated hydrocarbons. The resultant mixture is subjected to the action of a calcined mixture of precipitated hydrogels of silica, alumina, and zirconia at a temperature between 500° and 800° F. for a sufficiently long time to convert a substantial portion of the heavier oil into gasoline and to effect substantial saturation of gasoline boiling olefins.

J. D. Seguy. U.S.P. 2,276,103, 10.3.42. Appl. 13.9.39. Production of motor and aviation gasolines by subjecting a hydrocarbon oil to thermal cracking treatment in substantially the vapour phase to effect conversion thereof into gas, gasoline, and intermediate products. The intermediate conversion products are returned to the thermal cracking operation; the gasoline is recovered; and the gas separated into a hydrogen methane fraction, a 2- and 3-carbon-atom fraction, and a 4-carbon-atom fraction. The 2- and 3-carbon-atom fraction is subjected, together with residual 4-carbon atom hydrocarbons separated at a later stage, to pyrolytic treatment, and the pyrolytic polymers and gases produced therein are combined with the products of the cracking treatment. The 4-carbon-atom fraction is polymerized to effect substantial polymerization of the olefins to *iso*-octenes and the residual 4-carbon-atom fraction from the polymerization mixed with the 2- and 3-carbon-atom fraction. *iso*-Octenes from the polymerization treatment are hydrogenated with hydrogen from the hydrogen methane fraction and *iso*-octane recovered therefrom.

R. B. Ewell. U.S.P. 2,276,171, 10.3.42. Appl. 30.4.40. Production of more valuable products from volatile-saturated gasoline by fractionating the gasoline to form a light fraction containing normal butane and a heavier fraction containing hexane and higher-boiling hydrocarbons. The light fraction is subjected to dehydrogenation to produce olefins, and the heavier fraction to aromatization to form aromatics. The latter fraction is mixed with at least part of the olefins, and the resultant mixture subjected to alkylation to react olefins with aromatics. Finally the alkylated aromatics are recovered.

A. V. Grosse and C. B. Linn. U.S.P. 2,276,189, 10.3.42. Appl. 31.3.39. Production of hydrocarbons in the gasoline range by reacting a butane with acetylene in the presence of aluminium chloride and hydrogen chloride at a temperature between 0° and 50° C., and under sufficient pressure to maintain a substantial portion of the butane in liquid phase. H. B. M.

Gas, Diesel and Fuel Oils.

642. Patents on Gas, Diesel and Fuel Oils. Standard Oil Development Co. E.P. 543,669, 9.3.42. Appl. 12.2.40. Method of improving the combustion characteristics of hydrocarbon fuels in high speed compression-ignition engines. An improved diesel fuel is obtained by adding a small proportion of a nitroalkyl nitrate to a hydrocarbon fuel.

Standard Oil Development Co. E.P. 544,417, 13.4.42. Appl. 8.10.40. Preparation of a compression-ignition engine fuel consisting of a hydrocarbon oil boiling above the gasoline range and 0·2–3% of an organic compound containing a five-membered heterocyclic ring containing nitrogen and sulphur.

Standard Oil Development Co. E.P. 544,492, 15.4.42. Appl. 15.10.40. Process for increasing the stability and reducing the tendency to increase in knocking characteristics during storage of compression-ignition fuels consisting of mixtures of hydrocarbons boiling above the gasoline range and ignition promoters. From 0·01 to 0·1% by weight of a stabilizing agent comprising thiazole or thiazoline is incorporated in the fuel.

L. A. Clarke. U.S.P. 2,274,665, 3.3.42. Appl. 11.10.38. Manufacture of a liquid diesel fuel for compression-ignition engines. The fuel contains a small quantity of trichloronitro-methane.

L. A. Clarke, E. F. Pevere and W. N. Meyer. U.S.P. 2,274,666, 3.3.42. Appl. 5.10.40. Preparation of an improved diesel fuel consisting of a hydrocarbon fuel oil and a minor proportion of a compound selected from the group consisting of dichloro-dinitro-methane, dichloro-tetranitro-ethane, and tetrachloro-dinitro-ethane. The addition compound is present in sufficient amount to decrease the ignition delay period of the fuel, improve its cold starting ability, and decrease its tendency to deposit carbon and carbonaceous materials in the motor combustion chamber.

H. B. M.

Lubricants and Lubrication.

643. Patents on Lubricants and Lubrication. P. G. Colin. U.S.P. 2,276,162, 10.3.42. Appl. 17.12.40. Preparation of a mineral lubricating oil consisting of a viscous hydrocarbon oil normally tending to deteriorate in service and a small amount of di-α-naphthylamine to prevent such deterioration.

C. F. Prutton. U.S.P. 2,276,341, 17.3.42. Appl. 21.12.38. Preparation of a lubricating composition consisting of a hydrocarbon oil, 0·1–5% of naphthenate, and a separate halogenated organic compound.

S. E. Jolly and J. H. Perrine. U.S.P. 2,276,492, 17.3.42. Appl. 16.2.40. Preparation of an extreme-pressure lubricant consisting of a lubricating oil and a minor percentage of amyl benzene dichlor phosphine.

A. H. Gleason and W. J. Sparkes. U.S.P. 2,276,956, 17.3.42. Appl. 22.6.40. Preparation of a lubricant consisting of a hydrocarbon oil blended with a minor proportion of a chemically combined addition product of a high-molecular-weight unsaturated polymeric hydrocarbon and an alkyl hypochlorite. H. B. M.

Asphalt and Bitumen.

644. Patents on Asphalt and Bitumen. Standard Oil Development Co. E.P. 543,625, 5.3.42. Appl. 9.10.40. Method of preparation of a cold-laid paving mixture which involves the incorporation of a wetting agent in a mineral flux oil and the addition of powdered brittle asphalt to the flux oil. Thereafter the whole mass is mixed with mineral aggregates.

D. E. Carr. U.S.P. 2,276,155, 10.3.42. Appl. 7.2.39. Production of asphalts having air-blown characteristics by separating an asphalt residuum into an asphaltine fraction, a resin fraction, and an oil fraction. The oil fraction is blended with the asphaltine fraction to produce a composited asphalt which is substantially free from resins. Finally the blend is oxidized.

U. B. Bray. U.S.P. 2,277,842, 31.3.42. Appl. 5.3.38. Production of oxidized asphalt by blending an oil which will oxidize into asphalt with an oil which has been extracted from an asphalt containing oil by means of a solvent capable of dissolving oil, but not substantial quantities of asphalt. The blend of oils is then oxidized at high temperature with an oxygen-containing gas to produce an oxidized asphalt having a higher weather-ometer test than can be produced by oxidation of the original oil.

H. B. M.

Special Products.

645.* Petroleum Rubber. O. W. Wilcox. *World Petroleum*, February 1942, **13** (2), 26.—The history of the developments which have taken place in synthetic rubber production in Germany, Russia, and the U.S.A. is traced, and differences in the methods of approach to the problem are pointed out. Present production in Germany is thought to be about 100,000 tons a year, mainly of Buna S type, the butadiene required being produced via acetylene from carbide. Russian annual production is also reported to be about 100,000 tons, the butadiene being produced from alcohol by passing the vapours over a catalyst of mixed aluminium and zinc oxides at 400° C. With the loss of sugar-beet areas, the Russians may be forced to use carbide or petroleum hydrocarbons as their source of supply in the future. Up to the present, American policy has been to produce synthetic rubbers of special character to meet requirements for which natural rubber was unsuitable, but the present programme involving the manufacture of 400,000 tons a year is expected to be met mainly by production of Buna S. The necessity for increasing recovery of butane from petroleum sources as raw material for butadiene manufacture is therefore stressed. R. A. E.

648. Patents on Special Products. British Thomson-Houston Co., Ltd. E.P. 543,552, 3.3.42. Appl. 5.11.40. Preparation of a mineral electrical insulating oil to which has been added a small quantity of a derivative of the piperazine group in order to improve the non-sludging quality of the oil.

Standard Oil Development Co. E.P. 544,776, 27.4.42. Appl. 22.10.40. Improved process for the catalytic reforming of hydrocarbon oils in the presence of hydrogen and a finely divided catalyst. After separation from the products of the reaction and the hydrogen, part of the catalyst is subjected to regeneration and recycled to the reaction chamber, together with the remainder of unregenerated catalyst.

E. C. Pitzer and L. Heard. U.S.P. 2,274,633, 3.3.42. Appl. 21.2.40. Method of preparing a hydrocarbon conversion catalyst which involves treating amalgamated aluminium with a dilute solution of acetic acid containing chromic acid, and heating the resultant solution. Finally, the product is dried.

F. O. Rice. U.S.P. 2,275,232, 3.3.42. Appl. 1.6.39. Treatment of hydrocarbons capable of thermal decomposition to form olefin hydrocarbons of lower molecular weight. A small proportion of oxygen is mixed with the hydrocarbons at a temperature insufficiently high to effect any reaction of the oxygen with the hydrocarbons. The resultant mixture is heated rapidly in the absence of halogen and halogen compounds to a temperature sufficient to promote decomposition of the hydrocarbons. The oxygen present in the mixture accelerates decomposition. H. B. M.

Detonation and Engines.

647.* Performance of a Converted Petrol Engine on Producer Gas. J. Spiers. *Inst. Aut. Engrs J.*, 1942, **10** (5), 105–128.—A 6-cyl. petrol engine was converted to operate on gas generated in an "Emergency" type producer using anthracite. With the standard 6 : 1 compression ratio the maximum power under the best possible conditions was only 53% of that obtained with petrol; further reduction, which occurred as the charge of fuel was consumed, was not entirely compensated by advancing the ignition. For mechancial reasons the compression ratio could only be increased to 7 : 1; this raised the maximum power to 61% of the original maximum on petrol. At the higher compression the original power could be recovered by using 72–84% of the original consumption of petrol. It appears that high compression ratio, with petrol assistance when maximum power is needed, offers the best solution to the problem of power recovery. Cylinder wear was high, and it is concluded that gas filtration will have to be much improved. Lubricating oil viscosity showed a marked tendency to increase with use. K. A.

Coal and Shale.

648. Patent on Coal and Shale. E. H. Records and J. E. Louttit. U.S.P. 2,276,342, 17.3.42. Appl. 18.10.37. Process of recovering hydrocarbon oils and gases from oil-shale by enclosing a mass of shale in a reaction retort upon a base of coal, then passing steam through the coal and oil shale to effect decomposition. The operation is carried out in such a manner that decomposition products from the coal pass through the mass of oil-shale. H. B. M.

Statistics.

649.* World Production for 1941 up by 4·68%. Anon. *World Petrol.*, February 1942, **13** (2), 37.—In 1941 the U.S.A. oil production was 1,405,830,000 brl., 3·89% above the 1940 figure. Oklahoma the Eastern area, and Illinois showed declines in output, while Texas, Kansas, and Louisiana showed increases. The South American production of 304,918,000 brl. was 38,092,000 brl. higher than in 1940. Venezuela alone accounted for this rise. There were declines in production in Peru and Colombia in 1941, whereas Argentina had a slight rise. Official figures are lacking for Trinidad.

For the rest of the world estimates alone are available, and Zavoico is of the opinion that Russia showed an increase in output in 1941, while all the other European countries experienced decreases. A decrease of 5·72% is estimated for the Middle and Far East. G. D. H.

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Geology and Development.

650.* Rhythm of Permian Seas—A Paleogeographic Study. J. M. Hills. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 217–255.—In spite of some practical disadvantages inherent in the diastrophic method of correlation, J. M. Hills believes that a classification of the Permian must have a sound physical background. He summarizes the palæophysiography of this period in the southern Mid-Continent with especial reference to the West Texas Permian basin. Seven palæogeographical maps are presented, drawn on the following key horizons: latest Pennsylvanian (Thrifty), Wolfcamp (Coleman Junction), lower Leonard (Choza), San Andres (Blaine), middle Guadalupe (Grayburg), Castile and Salado, and Rustler. The regional correlations involved in making the maps are discussed, and several supporting cross-sections are illustrated.

From data on the areal extent of the Permian seas several curves are constructed. These emphasize the more salient characteristics of the period and disclose much of the basis of classification of the system. An account is given of the relation of this study to the standard Permian section for North America set up by Adams *et al.*

The Wolfcamp epoch was initiated at the close of the Marathon–Ouachita orogeny by the expansion of the normal marine seas, and was closed by a shrinkage of these seas. Leonard time began with a restriction of marine circulation, resulting in the

deposition of the evaporites of the Wellington and Valera. This epoch was characterized by the great development of evaporites in the Yeso, Clear Fork, and Salt Plain, by the advance of largely saline and brackish water in the San Andres, and by the subsequent retreat of the seas into the Delaware basin. The Guadalupe epoch began with the sea confined to that basin. Moderate floodings are typical of it, and marginal reefs separated marine from more highly saline waters. The epoch closed with the sea again restricted to the basin, and a probable increase of salinity caused the extinction of its greatest reef, the Capitan. The Ochoa commenced with exclusively saline seas in the Delaware basin, and terminated with regional uplift and the deposition of uppermost Permian sandy shales. J. T.

651.* Subsurface Geology of the Sewell–Eddleman Area, Young County, Texas. P. L. Applin and R. F. Imbt. *Bull. Amer. Ass. Petrol., Geol.*, **26** (2), 204–216.—The Sewell–Eddleman area in Young County, Texas, was discovered in January 1937. Fifty-nine producing oil- and gas-wells have been completed within the area and six producing zones have been encountered at depths ranging from 2300 to 4500 ft. The principal producer so far developed is a porous zone in the lower part of the Caddo limestone (Pennsylvanian). All but the lowest producing zone, which is Mississippian, are in rocks of Lower Pennsylvanian age.

The structure and producing area of the Sewell field have been closely defined by wells on the north flank, but on the south and east sides, and in the Eddleman area, fewer wells have been drilled and structure and extent are less well known.

The structure is described as an anticlinal fold, approximately 6 ml. long and 2 ml. wide, the major axis of which trends nearly east and west. Closure increases with depth. In addition to east–west folding, in the Caddo limestone a series of secondary folds control to some extent the accumulation of oil and gas.

The average density of wells in the Sewell field is now about one well to 35 acres.

Under the Carboniferous there is Ellenburger dolomite (Ordovician) with some oil staining. J. T.

652.* New Interpretation of Some Laccolithic Mountains and its Possible Bearing on Structural Traps for Oil and Gas. C. B. Hunt. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 197–203.—In the Colorado Plateau of South-eastern Utah the domal structures averaging 6 ml. diameter of Mounts Pennell, Hillers, Holmes, and Ellsworth are attributed to the injection of stocks of diorite porphyry. In each case the space occupied by the intrusion would approximately be closed if the formations tilted up around the igneous cores were returned to horizontal. Allowance must also be made for stretching which accompanied the arching of the domes. This deformation should be measured in terms of area, and not along linear cross-sections, since the stretching was mainly circumferential, probably along shear-planes, and the upturned beds were compressed outwards from the stocks.

Anticlinal noses radiating from the centres of the larger domes are due to off-shoots in the form of irregular, tongue-shaped laccolites. These are of relatively small volume; and their emplacement caused much less thermal alteration than did that of the stocks. If the large domes were to be credibly attributed to symmetrical mushroom intrusions, the required laccolites would have to be of the order of twenty times as big as any that can be observed. Arching is, therefore, best explained by vertical push, as if by the stocks.

A comparable igneous core at Marysville Buttes, California, has been shown by drilling not to be a mushroom laccolite. Other cylindrical intrusions giving rise to domes may include those at Moccasin Mountain, Montana; Carrizo Mountain, Arizona; Bear Butte, Dakota; and those in the Piatigorsk region, north of the Caucasus. A more problematical case is the huge dome, without exposure of core, at Nördlingen, Germany.

Stocks in petroliferous regions may, it is suggested, act like salt domes, and oil and gas may collect in adjacent inclined strata. A. L.

653.* Upper Cretaceous Formations and Faunas of Southern California. W. P. Popenoe. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 162–187.—The Upper Cretaceous of the Santa Ana Mountains, 50–75 ml. south-east of Los Angeles,

amounting to about 2600 ft. of conglomerates, shales, and sandstones, contains two main fossil assemblages: the older, *Glycymeris pacificus* fauna, with two sub-divisions, (*a*) *Trigonarca californica* and (*b*) *Cucullaea gravida* zones; and the younger, *G. veatchii* fauna, with three, (*a*) *Turritella chicoensis*, (*b*) *T. chicoensis perrini* and (*c*) *Metaplacenticeras pacificum* zones—in ascending order.

In the Santa Monica Mountains, 20 ml. west of Los Angeles, the top 300 ft., in a column of over 8000 ft. of coarse clastics, yield fossils of *Metaplacenticeras pacificum* age. The finer clastics, over 6000 ft., of the Simi Hills, 25 ml. north-west of Los Angeles, provide fossils in the lowermost 500 ft., which correspond with those of the two highest sub-divisions.

In the Santa Ana Mountains two major formations are distinguished, the Ladd and the Williams. The Ladd comprises: (1) the Baker Canyon conglomerate resting comformably on the reddened and poorly graded Trabuco (high Lower or basal Upper Cretaceous), from which it differs in being better sorted and in containing less deeply weathered boulders of andesites and schists; (2) the Holz shale, well exposed in Silverado Canyon, and showing local lenses of conglomerate, grit, or thin concretionary limestones.

It is within the Holz shale that the transition from the *Glycymeris pacificus* fauna to that of *G. veatchii* takes place.

The Williams formation of boulder-beds and light-coloured, felspathic sands is divided into: (1) the Schulz member with loosely cemented blocks of cherts, quartzite, and volcanic and plutonic rocks; (2) the Pleasants member, which has fine, ferruginous, and micaceous sandstones interbedded with thick, cross-laminated sands and sandy limestones.

The overlying Martinez conglomerate (Eocene) is marked near its base by the marine gastropod *Turritella pachecoensis*. It also contains clay and coal-beds.

A. L.

654.* Del Valle Oil-Field, Los Angeles County, California. L. A. Tarbet. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 188–196.—Oil is obtained from lenticular saturation in the Delmontian Stage of the Upper Modelo formation (Upper Miocene). Locally there is evidence of slight angular unconformity between Miocene and Pliocene, but this is not sufficient, in the Del Valle and Newhall–Portrero fields, to upset the deduction of structure from the Pico (Pliocene). The succeeding Saugus (Upper Pliocene and/or Pleistocene) is of coarse-grained, non-marine sediments, the junction of which with underlying marine beds, south but not north of the Santa Clara river, is an unconformity.

The Del Valle area occupies the east end of the Ventura basin of deposition; and oil concentration is on the Del Valle anticline, which trends east–west, and is bounded on the north by the Holser fault and on the south and east by downward plunge of the strata. Producing zones are 280 ft. and 900 ft. below the top of the Miocene, and are respectively 100–150 ft. and 200 ft. thick. The upper zone, with initial production of from 600 to 1500 brl./day of 32–36° gravity oil and 250,000 to 1 million cu. ft. gas, has water complications which also appear in what seems to be a continuation of the same zone in a western extension of the field. From the lower horizon initial production was estimated at 300 brl./day of 50° gravity oil with 10 million cu. ft. gas. When the gas zone was partly cased, production became about 900 brl./day of 33° gravity oil and 250,000 cu. ft. gas.

The two zones of the Del Valle oil-field may be equal to the second and third zones of the Newhall–Portrero field. This correlation is based on foraminiferal evidence, since faulting and much lenticularity make the exact use of electrical logs difficult.

A. L.

655.* Progress of Stratigraphic Studies in California. E. R. Atwill. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 153–161.—Superseding the maximum vogue of the reflection seismograph, which is still specially valuable for determining variation in the number of reflecting horizons in a sequence, attention is now being concentrated on stratigraphical investigation, since over 50% of Californian oil-fields prove to be of stratigraphical type. Electrical logging in wells and surface mapping of narrower lithological and palæontological units are localizing minor interruptions and giving fuller information about down-dip thickening and pre-depositional faulting.

Many parts of the Californina coast are natural laboratories where lagoon and sand-bar conditions can be observed with a view to interpretation of like features in oil-fields. The Gulf of California—a modern equivalent of the ancient sheltered embayments of San Joaquin and Salinas—is also being studied. One interesting result is that off-shore winds blowing down the Gulf drive silica-depleted waters out to sea, and a replenishment of silica-rich water from the ocean permits huge colonies of diatoms to flourish. In winter these die, so that pale layers, due to the silica of the diatoms, alternate with darker summer silts

13,000-ft. wells are penetrating the deeper portions of the geosyncline, and new ideas are arising about relations of sediments to the basement complex. The data of lateral changes can now be more fully illustrated by palæogeographical and isopach maps. A. L.

656.* Stratigraphy of Eocene between Laredo and Rio Grande City, Texas. J. M. Patterson. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 256–274.—A cross-section of the Eocene stratigraphical succession on the American side of the Rio Grande is in rather close agreement with results by Trowbridge, who failed, however, to classify the different members in the detail later worked out by Kane and Gierhart.

At the bottom of the succession, the Mount Selman consists of 700 ft. of Queen City sandstone and shales, overlain by 300 ft. of marine and non-marine shale and sandstone. Above this, the Cook Mountain formation is divided into three members: basal sandstone, 500 ft. thick; middle shale and sandstone, 700 ft.; upper sandstone, 500 ft. The subsurface top of the Cook Mountain formation, taken at the uppermost occurrence of *Ceratobulimina eximia*, is about 500 ft. below the top of the Cook Mountain as mapped at the surface.

Cycles of deposition in the succeeding Yegua are found to be very similar to those of the Fayette. The Mier and Loma Blanca sandstones in the Yegua; and the Salineno, Roma, and Sanchez sandstones of the Fayette, have a marine facies where they cross the Rio Grande in Starr and Zapata Counties. These marine sands wedge out northwards, and the shale concomitants become increasingly non-marine. It is suggested that each sandstone wedge and its associated shales represent a cycle of transgression and retreat of the sea. J. T.

657.* Gas in Rockingham County, Virginia. P. H. Price. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 275.—In the strongly folded middle Appalachian region, near Bergton, a rock pressure of 1150 lb. and an open flow of over 60 M cu. ft. gas are recorded in a boring to 2992 ft. which just enters Oriskany sandstone (Devonian). Analysis shows methane 98·69%, ethane 0·12%, propane + 0·01%, nitrogen 1·18%, carbon dioxide nil; Thv = 987. Large open structures between this locality and the producing areas 70 ml. to the west, suggest the likelihood of further similar discoveries. A. L.

658. Note on the Sealing Effect of Fault Surfaces. G. S. Taitt. *Journ. Inst. Pet.*, June 1942, **28** (222), 109–112.—A summary of a paper on the above subject, which was read at a meeting of the Trinidad Branch is presented. Possibilities of fluid migration and water-flooding across fault-planes are studied. A. H. N.

659. Typical Oil-Field Structures: Regular Anticlinal Fold: Kettleman Hills Field, California. Anon. *Oil Gas J.*, 4.6.42, **41** (4), 50.—Kettleman Hills is on the west side of the San Joaquin Valley, near the southern end. The basement of the Valley deposits is a pre-Cretaceous complex, which is faulted. On the eastern side of the valley the Eocene and Cretaceous wedge out between the basement and the Miocene. The Miocene beds extend completely round the southern part of the valley, and are overlain by Pliocene marine and non-marine beds with thick deposits of Pleistocene and Recent over much of the valley. Near the western edge of the valley there are about 25,000 ft. of beds. In the Kettleman Hills area movements were frequent from the Jurassic onwards, giving many wedge edges.

Kettleman Hills has two elongated domes, with only the North Dome giving important oil production. This dome has 2000 ft. of closure in the Temblor which is productive. The south-west flank has maximum dips of 45°, and the north-east flank 35°. The crest has a series of faults. The Avenal (Eocene) is also productive.

The Kreyenhagen below the Temblor is highly bituminous. Some consider this to be the source-rock. Other possible source-rocks are the brown shales above the Temblor and shale equivalents of the producing sands downdip.

Most of the fields of the Los Angeles basin are anticlinal. Anticlines are common in the Rocky Mountain area.

Some anticlines are obvious at the surface, but others are discovered by geophysical methods or subsurface geological work. G. D. H.

660. Typical Oil-Field Structures : Truncated Faulted Anticline—Oklahoma City Field, Oklahoma. Anon. *Oil Gas J.*, 7.5.42, **40** (52) 56.—The Oklahoma City field lies on the Nemaha granite ridge, and its main oil production is obtained from the Arbuckle lime. The structure shows evidence of uplift in Mississippian times, levelling, and then inundation by the Cherokee sea. The east flank of the anticline is downfaulted, some faulting persisting after Lower Pennsylvanian times. During the period of erosion the Arbuckle was exposed in the crest of the fold. Differential movements caused the structure to be reflected in the Permian beds.

The main oil-bearing horizons are in the Wilcox, Simpson, and Arbuckle, below the unconformity at the base of the Pennsylvanian. The Pennsylvanian yields gas mainly, with oil in small areas round the flanks of the structure. This oil differs from the lower oil. The fault forms the eastern boundary of the oil production, except for a few small local uplifts which give Wilcox production.

A post-unconformity source is postulated for the oil, since the Ordovician rocks carry oil only if they are exposed at the unconformity.

Garber, Crescent, Edmund, and Moore are similar fields on the Nemaha granite ridge, and other "bald-headed" fields occur on the Central Kansas Uplift. The Texas Panhandle is of this type.

Many of these deeply buried truncated folds are shown at the surface by a gentle fold or terrace. Subsurface geology is difficult as a means of detection, but if the conditions are favourable, seismic or gravimetric methods may be applied. The crest of these structures is not always the most promising part. Although many of these structures are faulted, faulting rarely seems to provide the trap. G. D. H.

661. Geology and Development of the Paloma Field, Kern County, California. J. T. Wood. *Petrol. Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1471, 1–7.—The Paloma field lies 17 ml. south-west of Bakersfield, in the San Joaquin valley. The first condensate producer was completed in August 1939 at a depth of 10,178 ft., and gave condensate at the rate of 2280 brl./day and gas at the rate of 14,750,000 cu. ft./day. In 1934 a small gas pool had been developed at about 5200 ft. in the San Joaquin clays. This was known as the Buena Vista gas-field. It was renamed Paloma, and the Paloma gas-field is productive from six wells in several zones in the interval from 4177–5548 ft.

The Paloma distillate wells penetrate Recent to Upper Miocene beds. The Paloma producing zone (Stevens sand zone, Upper Miocene) is at 9950–10,300 ft. The massive, hard sand, interbedded with siliceous shales, frequently contains material resembling Grahamite. The effective thickness of the producing zone is 200–250 ft., with porosity averaging 20% and permeability under 100 millidarcys. The underlying Lower Stevens zone is chiefly shale. There are indications that the Paloma producing zone is thinner and less permeable south-west of the axis of the structure, which is believed to be a large faulted dome. The Stevens sands may grade into richly organic shale towards the centre of the Buena Vista–Kern Lake basin to the south. The fold, discovered entirely by geophysics, is 9 ml. long, and may have 500 ft. of closure. The ultimate productive area is estimated at 3000 to over 5000 acres, but the field is not yet fully defined. G. D. H.

662. Gulf Coast Region is Ready for Expanded Exploration to Meet Increased Needs of Nation's War Effort. F. L. Singleton and N. Williams. *Oil Gas J.*, 25.6.42, **41** (7), 52–54).—Transport difficulties and drilling restrictions have caused a slackening of development on the Gulf Coast. The area is rich in crudes suitable for special fuels and products, and there has been an increase in exploration and leasing in spite of the restrictions. Twenty fields were discovered in the first five months of 1942, and

major extensions and new sand discoveries have also been made. Six wildcats being completed on 1st June have showings of oil and gas, indicating probable new fields.

846 wells were completed during the first five months of 1942, 348 on the upper Texas Gulf Coast, 262 on the lower Gulf Coast, and 236 on the Louisiana Gulf Coast.

The largest decline in drilling has been on the Louisiana Gulf Coast, largely due to the 40-acre rule restricting salt dome exploitation. Nine new discoveries are on the Upper Texas Gulf Coast, eight on the Lower Gulf Coast, and three on the Louisiana Gulf Coast.

The most active area is in Jackson County, where Frio sand discoveries continue to be made. Wildcat operations are expected to be concentrated along the Wilcox trend. Six Wilcox fields have been found this year. The Wilcox production now ranges 1900–11,775 ft. in depth.

Prolific oil production has been found down dip in the sands which yield gas-distillate at Agua Dulce–Stratton. At South Caesar the first commercial oil production has been found in the Carrizo–Wilcox at 6500 ft. and 6600 ft. Gas-distillate has been obtained at 11,660 ft. in the Hayes field. The Bay De Chene gas-field has proved to be associated with a salt dome, and oil has been found at 7470–7500 ft.

Tables summarize the completions and drilling operations by districts on 1st June, 1942, and 1st June, 1941. G. D. H.

663. More but Smaller Discoveries in Trend along Gulf Coast. W. V. Howard. *Oil Gas J.*, 25.6.42, **41** (7), 104.—In the areas bordering the Gulf of Mexico from Mississippi to the Rio Grande area 7,515,160,000 brl. of oil have been found, and of this 2,748,151,000 brl. have been produced.

The first two ten-year periods from 1901 had discovery rates averaging about one and a half fields per year. In the 1922–26 period, which saw the introduction of geophysics, the average was 3·6 per year. The rate was 10·4 per year in the 1927–32 period, 20·6 in the 1932–37 period, and 44·6 for the 1937–42 period. The average size of the fields was greatest in the 1901–11 period (50,000,000 brl.). After a decline it rose to 34,500,000 brl. in 1922–27, and then declined again.

At present fields are being found by a combination of geology and geophysics, and while the trend is still upwards, the rate of discovery may be expected to decline in the near future.

In South Texas production follows certain trends where structural axes cross wedging out oil-bearing beds. The fields are usually smaller than in the other districts. Early production in the Lower Gulf Coast area was from shallow Miocene beds. Later large reserves were found in the Frio. Discoveries in the Upper Gulf Coast area were entirely due to geology until 1925. A similar state of affairs obtained in South-west Louisiana, but in South-east Louisiana all the discoveries are due to geophysics.

Random drilling has found 6% of the coastal fields with 1·5% of the reserves; geology, shows, and core-drilling 37% of the fields (37·5% of reserves), and geophysics 57% of discoveries (61% of oil).

Tables show the number of discoveries and amount of reserves found in the different sectors over certain periods, and the production, amount of reserves, and modes of discovery for each year by districts. G. D. H.

664. Complete Report of Gulf Coast Field Development. Anon. *Oil Gas J.*, 25.6.42, **41** (7), 94.—Tables give the fields alphabetically according to districts, with discovery year, number of producing wells, daily average and cumulative production, producing formation and depth, sand thickness, type of structure, oil gravity, and outlet. A series of maps is included. G. D. H.

665. East Texas Wildcat Campaign only Moderately Successful. R. Ingram. *Oil Gas J.*, 28.5.42, **41** (3), 82.—Of 2,325,000,000 brl. of oil produced in East Texas, 1,911,000,000 brl. have come from fields in the East Texas basin, and all but 1,000,000 brl. of this is from the Woodbine sand. Much of the Mexia fault-zone production is from the Woodbine. Among a number of minor pools, such important Woodbine pools as Cayuga and Hawkins have been brought in during the past decade. These are mainly in anticlinal traps in the deeper part of the basin. East Texas is a shore-

line stratigraphic trap, Boggy Creek is a piercement type salt dome, and Van is probably a deep-seated salt dome.

The entire floor of the basin is covered by 35–150 ft. of Woodbine sand.

Below the Woodbine, Lower Trinity and Marine pays have been increasingly explored since 1939, and while no major fields have been opened, a number of gas-distillate pools have been found.

Concord is the only important discovery in this area this year.

Since 1920 291,920,000 brl. of oil have been produced from the Mexia fault zone fields, mostly from the Woodbine. Last year Pettit production and a gas-distillate pay in the Glen Rose were found. The Lower Trinity and Marine pays are considered favourable prospects. West of the fault zone, the Smackover appears to have possibilities in view of recent developments in Southern Arkansas.

Along the flank of the Sabine uplift a number of pools, mainly small, give oil from the Lower Trinity and Marine group. On the uplift production is chiefly from the Glen Rose and older Lower Cretaceous.

The East Texas fields are listed, with the date of discovery, number of wells, daily average and cumulative production, depth, oil gravity, etc. A map is included.

G. D. H.

666. West Texas Development, Production, and Reserve Data by Fields. Anon. *Oil Wkly*, 4.5.42, **105** (9), 32.—The discovery data, producing depth and formation age, developed acreage, number of oil and gas wells, daily allowance in January 1942, cumulative production, estimated reserve, oil gravity, and the depth of the deepest test, with the formation reached, are given for each field, the fields being arranged alphabetically under alphabetically arranged counties. G. D. H.

667. West Texas–New Mexico Permian Basin Presents Largest and Most Prolific Proven Undrilled Oil Reserve in the United States. H. H. King and G. M. Wilson. *Oil Wkly*, 4.5.42, **105** (9), 29–31.—The Permian basin has more proven and undrilled locations than any other geological province in U.S.A. Up to the end of 1941 1,499,351,000 brl. of oil had been produced, 1,195,073,000 brl. from the West Texas sector, which is credited with 2,564,831,000 brl. of the 3,000,000,000 brl. estimated reserve. Production is obtained from the Lower Permian and the Ordovician, and highs which are non-productive in the Permian remain prospects until explored down to the Ellenburger. Except at Big Lake, Ordovician production has been slow in attaining prominence. In 1936 Ordovician oil was discovered at Sand Hills on a series of highs within the Permian area, and in 1939 Ordovician production was found in Pecos County, where the Simpson and Ellenburger yield oil. Ellenburger production was found on the Barnhart structure in 1941.

Crinoidal and Silurian limestones also are productive in the Permian basin.

Yates has given 260,079,187 brl. of oil from 20,000 acres, and is estimated to have a reserve of 407,944,000 brl. Wasson, covering 58,000 acres, has a reserve of 414,950,000 brl., and Slaughter, which covers 52,000 acres, has reserves estimated at 279,532,000 brl. Goldsmith, North Cowden, Foster, and McElroy have estimated reserves of 311,000,000, 135,693,000, 109,978,000, and 127,280,000 brl., respectively.

Lea County has three distinct producing trends. Maljamar, Philmex, Corbin, and Vacuum are on one trend, Jal, Cooper Lynn, Eunice, and Monoment on a second. The third line lies east of the second.

Hobbs will pass the 100,000,000 brl. mark this year, and although most of its wells are ten years old, 89% of them still flow naturally. G. D. H.

668. Wilcox Trend Play may Extend into South Central Texas. F. L. Singleton. *Oil Gas J.*, 4.6.42, **41** (4), 72.—Since 1922 the trend of development has followed the same pattern, with the Edwards lime production important and possibilities of shallower production in the Taylor–Navarro series and Austin chalk. This fails to open new reserves, and so the search will be deeper or along new trends.

The Glen Rose is to be tested below 7000 ft. in Dimmit County, 4 ml. north-east of Atherton, and if this is unproductive, the Trinity may be tested. The first Glen Rose production was found on the Chittim anticline in 1929, and consisted of wet gas at 5600 ft. Recently a small producer was completed in this area in the Georgetown lime at 2966–3030 ft.

Wilcox production is now being sought over a large part of the Balcones fault-line

as a sequel to the discovery of Wilcox sand production in the Washburn area. A discovery seems to have been made in Wilson County near Poth.

Few tests have been drilled on the Edwards Plateau, but some have logged encouraging shows in the Pennsylvanian and Ordovician.

South-west of Pearsall a small discovery seems to have been made in the Austin Chalk or Edwards lime.

A table shows the fields, discovery date, number of producers, cumulative and daily average output, type of structure, depth, and oil gravity. G. D. H.

669. West Texas–New Mexico Oil and Gas Fields; Geological Data and Development History. Anon. *Oil Wkly*, 4.5.42, **105** (9), 43.—The oil-fields of West Texas and New Mexico are arranged alphabetically under alphabetically arranged counties, with brief notes on the discovery data, structure, producing formations, acreage, production at the beginning of 1942, cumulative production, number of producing wells, oil gravity, outlet, deepest test, principal leaseholders, etc. G. D. H.

670. Bottom-hole Contours Show Deeper Possibilities on Gulf. W. V. Howard. *Oil Gas J.*, 25.6.42, **41** (7), 125.—Contour maps with the bottoms of the deepest wells drilled as a datum can provide clues as to the possibilities of deeper production in many areas on the Gulf Coast. A series of maps show the greatest depths reached at different points, and the distribution of the deepest formations encountered on structure. Structural highs are revealed by the relatively shallower depth at which older beds are reached in areas where the wells are generally bottomed in a younger formation. The age of the oldest bed penetrated generally increases away from the coast, and also in going westwards along the coast, although the rate of the latter change is much smaller than that of the former. G. D. H.

671. Illinois Basin Discovery Rate Shows Drop this Year. H. E. David. *Oil Gas J.*, 14.5.42, **41** (1), 100.—When the known oil deposits are mapped with regard to the producing formations, the resulting picture of the Illinois basin displays definite trends or areas, in which the majority of pools produce from the same sand or series of sands. In this way the entire State falls into six areas, with a few outlying fields.

The Centralia–Salem area was opened by the discovery of Bartelso in 1936. Centralia, Salem, and Patoka followed quickly. Extensive exploration has continued to the present, Woodlawn being the latest discovery. Prior to the discovery of Devonian oil at Sandoval in 1938, all the development was in Pennsylvanian and Upper Mississippian sands, chiefly the latter. Many of the fields have Devonian production, and some have Lower Mississippian production. A small amount of Trenton oil has been found at Salem and Centralia. Most of the fields are on the Louden axis in a line with the Duquoin flexure. The structures are mainly anticlines and domes.

The Louden area has relatively few pools, and most of them are small. Important production occurs on the Louden–Salem axis, chiefly from Upper Chester sands. There is some Devonian production.

There was little production in the Dale–Hoodville area before 1939. Upper and Lower Chester sands give most oil. No sands have been tested below the McClosky.

Except for three recently discovered fields, all the fields of the Clay City area (Dundas, Noble, Johnsonville, etc.) produce from the McClosky. Tests have been made below the McClosky.

The Wabash River area has a 60-mile string of fields, and is the most recently developed area. The main pools are on a N.N.E.–S.S.W. trend parallel to the Wabash River. The principal pays are of Pennsylvanian and Upper Mississippian age. The sands are erratic in properties and distribution.

Almost all the fields in the La Salle anticline area were discovered between 1906 and 1912. The Pennsylvanian sands give the main production. There is also Chester, Devonian, and Trenton oil.

Data about the fields are tabulated and a map is included. G. D. H.

672. New Illinois Spacing Rules to Bring only Slight Drilling Gain. Anon. *Oil Wkly*, 1.6.42, **105** (13), 15.—Partial relaxation of well-spacing regulations in Illinois may cause a small gain in production. Since the beginning of the year output has

fallen by 100,000 brl./day, but the change may check this fall. The increase in drilling may amount to 20%.

With few exceptions, the best Illinois producing horizons are between 2800 and 3500 ft. The Bethel, Aux Vases, and McClosky, which give much of the output, are below 2500 ft. in most areas. The Cypress is frequently over 2500 ft. deep.

The new rule permits 20-acre spacing for wells less than 2500 ft. deep; 10-acre spacing if they are not more than 1500 ft. deep; 5-acre spacing if not more than 500 ft. deep. Hence the 40-acre spacing will operate in the most prolific horizons and in many of the new developments.

The Boulder field is giving 250–400 brl. wells in the Benoist at 1200 ft., and Griffin finds the Cypress at about 2400 ft.

Eight new fields were found in May, one of the discoveries being a McClosky lime well which gave 700 brl. in 12 hr. from 3333–3348 ft. A 200-brl. Trenton producer was completed in Madison County. Most of the strikes are below 2500 ft.

Tables give the completions by months since October 1941 and the fields with the spacing pattern which will be effective. G. D. H.

673. Condensate Field Spurs Texas Wilcox Activity. G. B. Nicholson. *Oil Wkly*, 8.6.42, **106** (1), 14–16.—The Wilcox yields gas with a high saturation of high-octane gasoline from several sands at Lake Creek. The deepest horizon is at 11,775–11,815 ft., some 3300 ft. of Wilcox having been penetrated. At least 5000 ft. of Wilcox is known to exist. Three main sands yield condensate.

The gentle elongated anticline was located by reflection work. The present producing area covers about 2000 acres. The discovery well, completed early in 1941, came in at 1,380,000 cu. ft. of gas and 170 brl. of 62·5-gravity distillate per day through a 17/64-in. choke at 9314 ft. Eight producing wells have been completed, with the sands at 9200, 9800, and 11,800 ft., while several other sands have appeared favourable in drill-stem tests.

Few cores are taken in drilling, but electrical logs are run before setting pipe. Gas/fluid ratios range 5000–10,000 to 1, approximately 7 gal. of distillate being obtained per 1000 cu. ft. The gas has 43·4% of hexane and 24·31% of methane.

Injection of gas is difficult, due to the high pressure and low permeability of the receiving sand. The two shallower sands have bottom-hole pressures of 3690 and 4280 lb./in.^{2}. G. D. H.

674. Important Midway Field Increases Steadily. Anon. *Oil Gas J.*, 4.6.42, **41** (4), 74.—The Midway structure seems to trend north-west–south-east, but it is not long and narrow, as was supposed earlier. There may be a fault limiting the structure to the south. The structure may trend east–west in the south.

A map shows the stratum contours on the top of the Smackover porosity. The crest of the producing zone seems to be at — 6023 ft. G. D. H.

675. Completions Climbing from Low Reached in March. Anon. *Oil Wkly*, 8.6.42, **106** (1), 33.—Since March the U.S.A. average daily completions have been increasing, and on 1st June about fifty more wells were drilling than on 1st May when 1999 wells were drilling. Increased activity is shown in California, Eastern States, Michigan, Illinois, and Kansas. 1538 wells were completed in the four weeks ending 23rd May. 9101 wells were completed during the first five months of 1942, 19·2% less than in the corresponding period of 1941.

Details of the well completions are tabulated. G. D. H.

676. Lea County, New Mexico, Development and Production Data by Fields. Anon. *Oil Wkly*, 4.5.42, **105** (9), 36.—The same series of data are tabulated as for the West Texas area. G. D. H.

677. Complete Third Well on Yondo Concession. Anon. *Oil Wkly*, 4.5.42, **105** (9), 93.—Casabe No. 3 on the Yondo concession in the middle Magdalena valley is reported to be giving 800 brl./day on test, with much gas. This is the third Yondo producer.

Tres Bocas 2-A, 12 ml. north-west of the Petrolea North Dome field, has been finished as a producer. G. D. H.

678. Reserves Show Slight Increase in 1941. M. T. Halbouty. *World Petrol.*, January 1942, **13** (1), 36.—31,356 wells were completed in U.S.A. in 1941, compared with 30,041 in 1940. 21,733 were oil-wells, 2840 were gas-wells, and 6783 were dry holes. During 1941 there was more geophysical activity than in 1940, and the number of parties may be comparable to the peak in 1939. Texas led in the number of new fields discovered, with California, Louisiana, and Oklahoma second, third, and fourth, respectively. The Texas lead in reserves was mainly through new sands and old field extensions. On the Gulf Coast new reserves have been obtained from the development of old piercement-type domes.

In California the greatest activity was in the San Joaquin Valley, but there were also discoveries in the Los Angeles Basin and in the Coastal districts. The Louisiana discoveries were greater than in any previous year, with the greatest activity on the coastal area. Drilling is proceeding in Mississippi, while geophysical surveying and leasing are going on in Alabama, Georgia, and Florida. Activity in the Mid-continent area is at about former levels. Shows have been found in the Hunton in Nebraska. Illinois had more discoveries than in 1940.

Except for Illinois, the new oil-field discoveries were not as great as before, although there is a slight increase in reserves, mainly from developments in semi-proven acreage, new sand discoveries, and extensions. At the end of 1941 the reserves were calculated to be 19,622,227,000 brl., 3·14% more than at the end of 1940. 1,402,288,000 brl. were produced in 1941. At the end of August 1941 the daily output exceeded 4,000,000 brl./day for the first time, and a peak of 4,336,850 brl./day was reached in November. G. D. H.

679. Increased Wildcatting Required to Maintain U.S. Reserves. F. H. Lahee. *World Petrol.*, March 1942, **13** (3), 54–57.—Statistics are presented regarding U.S. wildcats in eleven states during the years 1937–40. These include the numbers and footage, and the successes and failures are separated into groups according as the wells were located on a technical or on a non-technical basis. Whether the new reserves discovered in any year per wildcat or per foot of wildcat drilling, or the total new proved reserves per wildcat or per foot of wildcat drilling is considered, there are indications of a regular drop in the rate of discovery from 1937 onwards. This drop seems to be due mainly to increased difficulty in finding new traps. The remaining undiscovered reserves are largely either in regions not explored, deeper than the reservoirs exploited on known structures often unconformably related to the strata with the known reserves, or they are in stratigraphic traps. Hence, to maintain a satisfactory discovery rate calls for a more vigorous wildcatting campaign, with an increase both in numbers of wells drilled and in average depths. G. D. H.

Geophysics.

680. Geological Application of Nuclear Physics. C. Goodman. *J. appl. Phys.*, May 1942, **13** (5), 276–289.—Although this paper is written for the geology reader in general, there is sufficient in it to interest oil geologists in particular. The primordial source of all rocks appears to be a substratum of basaltic material lying a few tens of kilometres below the surface of the earth. The radioactive elements are presumably distributed fairly uniformly throughout this layer, but at concentrations substantially lower than are found in acidic surface rocks. This decrease of radioactive content with depth and increasing basicity is the result of differentiation from the source material. On cooling of any molten mass, crystallization begins, and chemical separation takes place in accordance with the existing pressure, temperature, and composition conditions. Certain mineral species, such as allanite, zircon, and sphene, seem to have crystal structure admitting a greater number of the large uranium and thorium atoms. Accordingly, if conditions are favourable to the formation of these minerals, which are usually only minor constituents in igneous rocks, the resulting rock may show localized concentrations of the radioactive elements. On the other hand, the more common rock-forming minerals, such as quartz, feldspar, pyrozene, amphibole, micas, and magnetite, are less tolerant of foreign radioactive atoms. During crystallization only relatively few uranium or thorium atoms are admitted, and these are found randomly distributed throughout the structures of the crystals.

The properties of the radioactive elements are briefly reviewed. This is followed by a study of geochronology. The helium and lead methods of measuring geological times are described. Geophysics, well logging, earth heat measurements, and geochemistry are briefly studied. Mineralization is reviewed, together with isotopic variations.

A new era in petroleum prospecting should result from an understanding of the origin of oil. Nuclear physics may well be of aid in solving this complex problem. Unless the present emergency makes it impossible, a systematic study of the genesis of petroleum will begin this year under the sponsorship of the American Petroleum Institute.

The calibration of γ-ray logs would make available a wealth of geochemical and geophysical data on sedimentary rocks. While terrestrial radioactivity measurements appear incapable of casting further light on the thermal state of the earth at depths, many important local and near-surface problems depend on this information. Hence, further geothermal radioactivity measurements would be of value, particularly if these were correlated directly with diffusivity and geothermal gradient measurements. The future should also see an extension of the application of neutrons in geophysics. Already the relative scattering coefficients of neutrons appear to be useful in well-logging. The results of this type of survey reveal the relative hydrogen content (largely in the form of water) in the formations. By extending the neutron-induced activity method to rocks, an indication of their mineral and fluid contents could be obtained. This application awaits the development of compact, intense neutron sources.

An extended bibliography is appended to the paper. A. H. N.

681. Theoretical and Economic Significance of Geodynamic Prospecting. S. J. Pirson. *World Petrol.*, April 1942, **13** (4), 38–41.—Since the start of the U.S.A. oil industry one out of twenty-five wildcats has opened a new field, and up to 1937, 6·5% of the wells drilled were wildcats. Wildcat statistics show that the resolving power of geophysics has decreased during the past five years, whereas the resolving power of geology or of geology and geophysics combined has remained essentially constant. Geology and geophysics combined were more successful than geophysics or geology separately, and the actual probability of success agrees with that predicted from the degrees of success of the individual methods when allowance is made for random discoveries.

During a period of ten months three commercial producers have been obtained out of five wells located by geodynamic prospecting, and one found good impregnation. Thus the resolving power of geodynamic prospecting is much greater than that of the other methods.

Examination of the resolving powers of the various methods and combinations of methods in conjunction with the cost per acre, leads to the conclusion that geodynamic prospecting, because of its cheapness and high resolving power, should be the first method applied, followed by geology and geophysics. G. D. H.

682. Radioactivity Logging Proves Help in Reworking Old Wells. Anon. *Oil Gas J.*, 25.6.42, **41** (7), 140.—Radioactivity logging has made possible a greater degree of precision in the location of possible oil-bearing formations which may be cemented off behind casing in old holes. The method tells nothing about the porosity, permeability, or fluid content of the porous formation. It merely shows the positions of sandstones or limestones and shales. Logs may be made in cased or uncased holes.

The gamma-rays emitted by elements in the formations are detected by use of an ionization chamber, the gas in which is a non-conductor, except when rendered conducting by the action of gamma-rays. The conductivity of the gas is a function of the intensity of the gamma-rays. The current passing through the gas is amplified and recorded continuously at the surface.

Sands and limestones generally have feeble radioactive properties, but shale-beds have stronger radioactive properties. Salt has low radioactivity, and anhydrite even less.

Radioactivity surveys have been used mainly for correlation and for the develop- of new production from cased-off sands. The surveys have also shown unknown faults, wedging beds, and that some wells have not been drilled deep enough. They

are useful for checking depth measurements, in setting casing, and in detecting the position of cement if the cement contains a little radioactive material. G. D. H.

683. Locating Cased-off Productive Zones. W. A. Sawdon. *Petrol. Engr*, May 1942, **13** (8), 55.—There is much economically recoverable oil cased off in various fields in the U.S.A., and probably all of it can be made recoverable without the use of new casing. The cheapness of the recovery will depend on how readily the cased-off oil zones can be located. In some cases data obtained during drilling will facilitate the location of these cased-off horizons, but in many older wells there are no reliable logs, so that radioactivity logging is of value in locating these horizons.

Radioactivity logs provide general geological information, and they can be made in cased holes. The intensity of the rays is decreased by steel casing and cement, but logs have been made through five strings of cemented casing. An ionization chamber with an amplifier is run in the well, and a continuous record is made at the surface. The sensitivity is adjusted to meet the conditions encountered. A high amplitude log gives a sharper definition of minor changes in the character of the formations.

Electrical logs, when available, facilitate the interpretation of the radioactivity logs. In California the shales are generally much more radioactive than the sands, although there are difficult areas.

A number of radioactivity logs are included with electrical logs for comparison, and examples are given of the application of radioactivity surveys. G. D. H.

684. Micromagnetic Surveys in the Sparta–Wilcox Trend of Texas and Louisiana. W. P. Jenny. *Oil Wkly*, 15.6.42, **106** (2), 20–23.—Purely stratigraphic traps without any structural factor are extremely rare. Thus East Texas is not only on the flank of the Sabine uplift, but on a distinct anticlinal nosing off this uplift.

The more detailed information that there is concerning an uplift, and especially concerning its flanks, the easier it is to assess the possibilities of finding stratigraphic trap production, since the chances will generally be better on local highs along the flanks. Geophysics in conjunction with subsurface investigations should therefore be of great value in searching for stratigraphic traps. A combination of geophysical methods may be helpful, provided that the limitations of the methods are considered. Seismic reflection and micromagnetic methods might profitably be combined.

In the Joe's Lake–Fred area early magnetic isogams indicated uplifts which were later proved to be productive. Some of the early Cockfield wells along the Sparta-Wilcox trend were on magnetic highs, but were structurally about normal. Thus an unconformity between the deeper Wilcox and the Cockfield was shown magnetically, for if the Cockfield is normal, magnetic beds below must be uplifted in order to give the anomalies. The Eola field conforms with these conditions. Its reflection profile indicates only 100 ft. of closure, because wedging of the low-velocity beds tends to veil the reversal of the dip when examination is made by means of the reflection seismograph.

In Western Montgomery and Southern Walker counties the Lake Creek field seems to be indicated by a local magnetic high. G. D. H.

Drilling.

685. Proper Operation of Wire Rope Prolongs its Useful Life. Part I. H. F. Simons. *Oil Gas J.*, 21.5.42, **41** (2), 38–39.—The following rules are stressed for maintaining ropes in good condition. (1) Keep wire-rope-using equipment in good condition. Sheaves should be of proper size, design, material, and free from corrugations. Keep all sheaves properly lubricated and in line. Avoid excessive fleet angles. (2) Keep wire ropes thoroughly and correctly lubricated. (3) Avoid kinks and sudden jerks; also, avoid cross-winding on drums, and reverse bends if possible. (4) Make sure wire ropes operate with an adequate factor of safety. If there is not a proper ratio between the strength of the rope and the maximum load to be handled, the rope may be over-stressed—a condition no rope can long survive. (5) Use wire rope of the correct size, construction, type, and grade for particular conditions. (6) Purchase wire rope in sufficient length to allow for changes in position on drum.

Wire-line management can be used effectively to increase the service life of a rope. Contractors or oil companies having both deep and shallow operations can remove the lines from their deep-drilling equipment, when they are no longer safe, and put them in service immediately on the shallower wells. A line the safety factor of which has been reduced to three or two on a 10,000-ft. well would still have an adequate safety factor on a 4000- or 5000-ft. well.

Probably the greatest increase in wire service is available through more careful operation of the drilling rig. Running into the load (string of pipe) instead of picking it up smoothly puts an undue strain on the strands and individual wires. The point of application of this strain on a drilling rig is generally when the blocks are at their lowest or uppermost position. This will cause premature failure of a line, due to concentration of the wear.

In connection with lubrication and corrosion, it is pointed out that the application of any type of lubricant on top of a coating of hydrated rust does absolutely no good, and if it forms it is necessary that the rope be thoroughly dried before any lubricant will take effect. For field application, suggestions are: (*a*) Rope lubricant of a reputable manufacture. (*b*) Fifty–fifty mixture of red engine oil and boiled linseed oil. (*c*) Red engine oil. (*d*) Discarded crankcase oil. (*e*) The same lubricant as applied during manufacture. A. H. N.

686. Proper Operation of Wire Rope Prolongs its Useful Life. Part 2. H. F. Simons. *Oil Gas J.*, 28.5.42, **41** (3), 48.—The life of wire rope could be increased if a systematic inspection programme were developed which would detect troubles when they first develop and would not wait until they become obvious. A rotary-drilling line should give somewhere between 8000 and 30,000 ton-miles of service. This average could probably be substantially increased if all users adopted a suitable inspection programme.

Methods of inspecting wire rope can be fairly well standardized, although inspection practices on rigs must necessarily vary to allow for the peculiarities of the individual installation. Evidences of deterioration in wire rope will, within fairly wide limits, be the same, regardless of where and how the rope is used.

Deterioration of wire rope will be evidenced by: (1) broken wires; (2) worn wires; (3) pitted or corroded wires; (4) drastic reduction in rope diameter and excessive lengthening of lay; (5) marks of mechanical abuse, such as flattening and distortion.

Inspection should include: (1) A quick check of the number of broken wires by rope lays, so that the worst lay can be selected. (2) A check of the diameter of the rope throughout its length should disclose any drastic reduction from the catalogue diameter at any point. (3) Inspection of the degree of abrasion wear occurring on the wires. (4) Noting carefully, not only in the worst broken-up section of the rope, but throughout its entire length, whether any signs of rust are appearing. (6) Noting carefully the condition of the rope near attached fittings. Causes of damage are tabulated. The significance of the different items of inspection is explained.

In addition to the number of breaks, the amount of stretch in a line also indicates the approach of the end of useful life. Applying loads to a 6 by 19 rope up to about one-half the rated breaking strength of the rope will show a total stretch equal to 0·2–0·3%. For correctly preformed ropes this stretch will be from 30 to 50% less.

In actual service the history of rope-stretch is always a guide to indicate when ropes absolutely must be removed from service. In the initial stages of rope life, rapid stretch always occurs, then a long period of negligible but rather constant stretch occurs, and finally, when the core starts to deteriorate rapidly and the wires within the rope start to break rapidly, the rate of stretch again becomes very rapid. When this latter stage of stretch begins the rope should immediately be taken out of service.

Proper inspection of wire rope must necessarily include examination of the equipment on which it is being used. The principal items to be checked are: (1) Sheaves. (2) Drums. (3) Reeving. (4) General operating conditions. These are studied in this part of the paper, giving general directions. A. H. N.

687. Maximum Service from Well-Surveying Equipment. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 185.—The Syfo instrument, having no moving parts or mechanism what-

ever, is probably the most rugged type of instrument of its kind. If properly assembled in its protective casing, no other precautions are necessary. The operation of the Syfo is dependent on the uniform and consistent flow of the recording fluid. To secure consistent operation, cleanliness is essential. It is suggested that after use the instrument chambers be flushed out with clean water to remove any foreign matter which might eventually get into the recording fluid and clog the orifice. The orifice chamber is protected by a fine-wire strainer. This strainer should be in good condition and should not be removed oftener than necessary. The recording fluid, as well as the interior of the Syfo, should be kept free from oil or grease, which might interfere with the flow of fluid through the orifice. A fresh supply of recording fluid should be made up frequently. Recording charts should be kept in the sealed container up to the time required for use. Hints are given on the proper use and maintenance of inclinometers.

The following hints are given for the case of the instrument of the go-devil type: (1) Do not handle the instrument or pneumatic shock absorber with gloves or dirty hands. If you do, grease, moisture, grit and dust may get into the precision mechanism and necessitate a factory cleaning or repair job. Instruments and pneumatic shock-absorbers are as precisely made as the finest watch, and the presence of any foreign material is very destructive to them. (2) Immediately after use, carefully wipe the instrument and pneumatic shock-absorber with a clean, dry rag. Place the rubber protective cap over the open end of the angle indicator tube and return it and the timing element to the wooden instrument box. Replace the pneumatic shock-absorber in the go-devil container tube. This will protect them from water, dirt, and damage. (3) Keep the wooden instrument box clean and closed. It is strongly made and felt lined and sealed to prevent damage to the instrument. Clean the inside of the box with a dry brush (never use water or solvent of any kind). (4) Never at any time use pliers or other tools on the instrument. Screw the timing element into the angle indicator tube, using only your fingers on the knurled surface, and bring it to a snug shoulder. If you do this, the joint can easily be taken apart after use. Remember these are finely made threads and the tube is made of thin, comparatively soft metal. While the instrument will give long, satisfactory service, it cannot stand abuse and rough handling. (5) Never tinker with, attempt to adjust, or lubricate the mechanical parts of the instrument or pneumatic shock-absorber. They are lubricated and sealed for life at the factory, and can be taken apart and serviced only by instrument men specially trained in this work. (6) The only lubrication required for the instrument and shock-absorber is (*a*) the coarse pin thread which connects the instrument to the shock-absorber, and (*b*) the fine thread between the timing element and the angle-indicator tube. Use only a very light oil, apply it very sparingly, and wipe any excess away immediately with a clean rag before screwing the parts together. (7) Never wash any part of the instrument or shock-absorber with water, solvent, or fluid of any kind.

Similar hints are given for go-devil and accessories. A. H. N.

688. Latest Type Piling Structure for Gulf Coast Marine Drilling. C. C. Pryor. *Petrol. Engr*, June 1942, **13** (9), 27.—Among the many serious obstacles to be overcome before a piling structure is ready for drilling operations is that of the formation into which the piling is driven, which may allow the structure to settle. At many locations soil-formation tests are made at piling structure locations.

One important practice adopted by engineers in construction of the structure is the method of scabbing used on each pile. In this instance, four 6 in. by 8 in. by 8 ft. scabbing were used to bolt the scabbing to the piling. The upper ends of the scabbing were tapered in an endeavour to facilitate removal of the piling after the well or wells had been completed. The lower ends were placed at varying distances from the end of the piling, depending on the depth to which the individual piling was to be driven. The bottom ends of the scabbing were driven into the most solid formation as a distinct aid in preventing settling of the structure. At some locations the formations through which the piling must be driven are so compacted that it is necessary to jet the piling to remove them. Removal of the piling other than that necessary around the well-head after completion is on compliance with Government regulations. Scabbing has been found to play a major rôle in preventing settling of the structure; however, another important practice adopted by engineers is the

capping and bracing of piling. These are discussed and illustrated as used in this plant. Equipment and derrick sections are detailed and dimensions given.

One of the most economical features of the piling structure is the ease with which more than one well can be drilled. On a similar structure, ten wells were directionally drilled for production, besides a water well to supply the needs of the rig. In addition to the drilling of several wells, the ease with which the entire structure is salvaged adds much to its economy. Obviously, the entire amount of steel S-beams used in the construction can be removed even more quickly than they were constructed. The piling need not be broken off, but may be pulled or jetted out.

Advantages of this system over sunken barge system are discussed. A. H. N.

689. Fibre Pipe Run for Casing in Shallow Illinois Oil Well. F. Squires. *Oil Gas J.*, 28.5.42, **41** (3), 61.—This method, utilizing a special Orangeburg fibre conduit material instead of regular steel casing, was developed by the Illinois State Geological Survey as a war emergency project to save steel and promote petroleum production.

The fibre casing, with a bottom length of steel casing, was lowered into the hole on a string of tubing, and supported at the bottom of the tubing string by a special shouldered shoe designed for the job. The shoe was toothed at the bottom to prevent the turning of the casing when the tubing was unscrewed. The anchorage is of importance, because the tubing connection with the shoe was made with left-hand threading. This threading design allowed the tubing to be rotated and free from the shoe after the cement was run, without loosening the shoe assembly, which was also threaded to the end of the casing.

The fibre casing was supported by the shoe, to avoid the possibility of parting of casing joints, since the joints were of the bevelled friction or "shove" type, with corresponding collars. The greatest departure from standard practice is the design and function of the shoe. This is described in detail.

As a result of the testing of this fibre conduit in an actual well installation, certain refinements suggest themselves in regard to future applications of the method described in this paper. It is believed that the cement can be reinforced with better results, and that more positive centering of the fibre conduit can be accomplished. In addition, some improvements in the design of the shoe can doubtless be made.

A. H. N.

690. Maintenance of Rotary Rig is Continuous Operation. H. F. Simons. *Oil Gas J.*, 30.4.42, **40** (51), 86.—On a schematic drawing of a standard two-engine rig, sixty-three items of maintenance are listed, together with instructions. The paper discusses the more important items in detail. It is suggested that instead of evaluating progress on hole made on time, it must be judged in the light of the damage and wear on the drill collars, drill pipe, and tool joints.

If steel were the only scarcity, a partial solution would be available by the use of rubber protectors on the drill-pipe. These are used to prevent contact between the drill-pipe and the walls of the hole. Some operators are already reclaiming as many drill-pipe protectors as possible from old strings of pipe no longer suitable for use. Instead of destroying them by cutting them off the pipe with a hatchet, protectors can be pressed off without damage from the worn-out pipe.

There are two ways open to prolong the life of the drill-stem. The first is to use less speed and less weight while drilling, and the second is to take better care of the drill-stem.

The term less weight is used advisedly, as with a properly designed drill-string more weight can be applied to the bit without damage than can be exerted with the ordinary drill-string. The use of a heavy drill-collar section on the bottom of the string has been advised for a number of years, the object being to concentrate the weight at the bottom and obtain a plumb-bob effect on the pipe in the upper portion of the hole. This prevents the tool-joints from contacting the abrasive side-wall formations, which wears them rapidly.

Unfortunately, most drill-stems are not properly designed, and the driller obtains the necessary force on the bit by supplementing the drill-collars with the weight of the drill-pipe. This causes bending of the drill-pipe, which develops an eccentric motion and contact between the pipe and the formation. The solution is less weight and lower rate of penetration, but an increase in the life of the pipe. This increase

in life is not one merely of days, but more vital; it is one of feet of hole made and oil-wells or dry holes completed. Details are given of other maintenance procedures to be taken with drill-pipe, joints, swivels, pumps, and weight indicators.

Other points which apply to practically all rigs, and which, if observed, would prolong their life, are: (1) Avoid shock loads. (2) Operate rig at speed below rated capacity. (3) Keep all bolts and nuts tightened. (4) Replace worn parts before they wear mating parts. (5) Avoid excessive acceleration and deceleration and preserve bearings and brake lining. (6) Keep suction lift as low as possible. (7) Keep elbows and restrictions in mud lines to minimum. (8) Do not lug engines. (9) Engage clutches as easily as possible. (10) Have a systematic checkover system. (11) Do not continue to operate rig when there is any trouble developing; shut down and repair it immediately. (12) Do not overload rig. (13) Do not tinker.

A. H. N.

691. Maintenance of Blowout Preventers. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 176.—In order to obtain maximum service life and most efficient operation from a blow-out preventer, it should be cleaned and lubricated at regular intervals. Drilling mud enters the working parts, and unless it is removed it causes corrosion and generally contributes to wear and improper operation. Detailed hints are given for maintenance of each part of the preventer.

A. H. N.

692. Boiler Maintenance. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 182.—Gas-burners are more often set too high than too low. A high burner leaves the bottom of the firebox cold and produces unequal strains in the metal, frequently causing staybolt leaks, besides reducing effective heating surface and combustion volume. A good rule is to have the top of the burner in line with the bottom row of staybolts. Still better results are obtained by setting the burners in a base below the firebox, with refractory protection for the mud-ring. This makes an excellent setting for stationary installations and will produce better combustion. Automatic dampers in the base are of advantage to regulate the flow of air or to shut off air when the burner is turned off. In any setting excessive cold air influx lowers the efficiency and may be harmful to the boiler by sudden cooling.

Oil-burners should be set in a well-constructed refractory "duck's nest," and flame impingement against metal surfaces must always be prevented. After new boilers are placed, they should be washed out thoroughly to remove all foreign matter and rust accumulations.

Firing up a new boiler is somewhat similar to a stress-relieving or normalizing process, adjusting the boiler parts to their normal heat-strains. It should be done very gradually, starting with a low fire for several hours and taking at least 18 hours more to build steam pressure gradually. Small leaks in a new boiler will often "take up" or tighten themselves after a short time, but if they persist they should be peened or caulked tight. Continuous leaking produces concentrated corrosion and may in time crystallize the adjoining metal. Seal-welding of leaks should never be resorted to unless the structure is sound, and then only if approved by an authorized boiler inspector. Seal-welding of leaks, or even tack-welding of attachments, on the newer type of "high tensile" steel must never be permitted. Any welding on this type of steel, without subsequent stress relieving, is harmful to the metal and may produce crystallized spots.

Scaling and dangers accompanied therewith, heat conservation, pitting by free oxygen, use of superheated steam are discussed. The power output of machinery on a drilling rig is in direct proportion to the volume of steam supplied; therefore the net increase of 18% in the volume of steam generated for only a 5·6% increase in heat added recommends the use of superheated steam as of unquestionable value.

Other notable operating improvements on a drilling rig result from the use of superheated steam. With saturated steam a noticeable amount of condensation and pressure loss occurs in the long steam line from the boiler plant to the rig. Under ordinary conditions such condensation is entirely eliminated and the pressure loss greatly reduced when superheat of 100° F. is used. The machinery operates more efficiently, lubrication is more effective, and the response to heavy demands is more prompt when dry or slightly superheated steam is used, because the mean effective pressure is increased.

The general use of superheated steam on drilling rigs and the modern equipment provided to make its use possible represent far-reaching economies and an increase in the capacity of the rig that no additional number of boilers can equal.

Use of insulation is discussed. The paper ends with a study of the correct use of steam-traps. A. H. N.

693. Cable-Tool Service Extended by Good Operating Practice. F. J. Spang. *Oil Gas J.*, 30.4.42, **40** (51), 103.—In the actual drilling operation much can be done to prevent wear on the exterior of drilling cables, rope sockets, tool-joint collars, and bit blades. The constant use of colloidal clays to condition the walls of the hole while drilling will close the face of sharp rock thus preventing a certain amount of wear. Such clays also tend to reduce both minor and major caving. Naturally, if caving is reduced it lessens the time consumed in pulverizing and mixing the cavings, as well as the amount of bailing needed.

In addition to these advantages, the use of colloidal clays tends to reduce the formation of mud balls and mud rings, and the consequent wear of the tools and drilling cable working them loose. Drilling sediment is more readily and consistently mixed thus lessening the amount of time consumed in pulverizing it and permitting a greater footage to be drilled with each run.

The proper care of joints is discussed. In mating joints they should first be set up without much stress and then separated and subsequently cleaned, at which time careful examination should be made for the formation of any wire or galled spots on either the threads or the face of the joint. If these have formed, they should be fully removed. The joints should then be set a second time, after which they should be recleaned. If this procedure results in proper joint action, the joints may be tightened and put into use. However, if the action is not proper, they should be separated and cleaned as often as is necessary so that a step-by-step mating of the joints takes place. Use of clean water is emphasized as well as the avoidance of overstresses.

Precautions to be taken with bits are: (1) The forge furnace should be large enough and smooth enough inside so that it will not crowd the flame or divert it to strike the bit directly and thus burn it. (2) The forge furnace should be deep enough to mix thoroughly the fuel and air, but put it into good even combustion before coming into contact with the bit. (3) The fuel entrance should be well below the bit and preferably in front of the forge. (4) The bit blade should not be stopped or blocked off with mud or wet ashes. (5) The fuel mixture should be rich, never a thin or cutting one, as such a mixture both decarbonizes the bit and heats exposed corners of the bit too hot before the body is warm enough to stand the consequent expansion. (6) Water courses should be cut out in such a way as not to leave corner cuts or deep grooves in them. (7) The bit should be allowed to cool to a fully black colour after dressing, and then a short end of the point reheated slowly and uniformly to an even cherry red in a rich flame. (8) The bit should be quenched only to have the corners submerged in the water. (9) Soft water gives the best hardening results. (10) A really cold bit should not be put into a hot flame, but should be laid in the forge without any flame until slightly warmed. (11) All seams, cracks and cold shuts should be kept chipped out of the bit at all times. (12) After a bit has been heated to high temperature, or several times to cut off and stove up to dress, it should be allowed to cool to a black colour and then be reheated to a temperature slightly above a hardening heat and again allowed to cool to a black before heating to harden. (13) Where the drilling is in extremely hard or abrasive formations, demanding a frequent change of bits, it has been definitely proved that a great saving of steel can be made by using a set of three bits instead of the conventional set of two. A. H. N.

694. Preventing Chain-Drive Failure. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 167.—It can safely be stated that from 90 to 95% of all chain failures in service must be attributed solely to causes beyond the control of the chain manufacturers. In other words, they are caused by incorrect application, installation or maintenance on the part of the user.

Improper lubrication is probably the greatest cause of premature failure. Causes important enough to be given consideration follow: (1) Entire absence of lubrica-

tion. (2) Operation in dirty conditions. (Dirt taking the form of a fine abrasive dust, a coarse obstruction to chain operation, or corrosive conditions.) (3) Imposition of overloads. (4) Misalignment of drive.

At slow speeds periodic lubrication with a good grade of medium mineral oil is usually adequate. This oil should be applied so that it will penetrate to the pin bearings or the chain belt will not be lubricated.

At moderate speeds, constant drip-feed lubrication should be provided. The drip should be directed to the upper edges of the side plates of the lower strand. At moderate speeds, fast-drip feed in enclosed casings, or oil-bath lubrication should be provided for chain-belt drives.

For high-speed heavy-duty drives, a pump-spray lubrication system represents the best, most economical and efficient system. Misalignment seriously abuses a chain belt. When misalignment is present, the loads imposed by the sprocket teeth are not located centrally on the chain roller. This results in uneven and hence more rapid pin-bearing wear. Also as the chain enters the sprocket, the side plates are struck. This results in wear on the plates, decreased efficiency and also destruction of the chain through loosening of the side plates.

These precautions will extend chain life: (1) Do not install chain on worn sprockets. (2) Do not run chain at excessive speeds. (3) See that locking devices and other parts are replaced as soon as their failure is noted. (4) Do not allow chain to slap or otherwise contact obstructions. (5) When replacing worn parts do so in the prescribed manner. Do not abuse chain at this time.

Notes are given on the design of roller chain drives. A. H. N.

695. Getting the Most Service Out of Transmission Belts. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 170.—Most important provisions in designing the new drive may be summed up as follows: (1) Equip the drive with a sufficient number of the correct-sized belts to handle a maximum load. (2) Use sheaves that are over the accepted minimum diameters. (3) Provide sufficient take-up, so that belts do not have to be discarded until they are worn out. (4) Don't leave tools, bars, or other material where they might fall into the drive and break the belt as the material passes between the belt and the sheave-groove. (5) Don't expect the drive to pull heavy overloads (above designated rating) for long periods. (6) If possible, protect the belt from the direct line of the sun while the drive is in operation. (7) Use standard sizes. To-day it is more than ever desirable to design drives to fit standard belts and standard sheave sizes. Replacements will be easier to obtain, and in fact it may not be possible to secure belts for any drives except those using standard sizes.

The facts which must be known in order to design a V-belt drive are as follows: (1) Maximum horse-power to be transmitted. This may be obtained from the rating of the engines or motors to be used. (2) Maximum speed of the driving and driven machines. This also may be obtained from the engine or motor ratings, or from requirements of the driven machine. (3) Space limitations. (4) Type of load to be handled. The paper discusses the design of V-belts in some detail. Installation and maintenance of belts are next studied. The substitution of leather for rubber belts and the peculiarities of these belts are outlined. Inspection of belts should answer: (1) Is the belting too dry? (2) Is it dirty? (3) Is it saturated with oil? (4) Is it too slack or too tight? (5) Are the pulleys in line? (6) What is the condition of laps and plies? (7) What is the condition of lacing and the ends of belts that are laced?

If belting is dirty, clean the surface. In extreme cases a blunt-edge scraper may be used: usually, however, the belt may be cleaned satisfactorily by washing with naphtha or gasoline. To avoid fire hazard, carbon tetrachloride may be substituted. When the belting has been cleaned, dressing should be applied sparingly: use of too much dressing will cause excessive slippage of belts. A small application will keep them from drying out or slipping. Some dressings penetrate the leather and act as lubricants, but have no beneficial effect on transmission qualities; others contain free fatty acids which materially shorten belt life. In fact, many dressings have little to offer except their stickiness, which often causes damaged grain and shortened belt life. A. H. N.

696. Clinton Sand Drilling and Production in Central Ohio. H. N. Ross. *Oil Gas J.*, 7.5.42, **40** (52), 55–56. *Paper Presented before the Natural Gas Section, American*

Gas Association.—The geology of the field is given briefly. All drilling in the area is with cable tools. Standard-rig equipment is generally used; however, some drilling is done with National machines, and a few wells have recently been drilled with spudders. The standard rigs have a 22-ft. base and are 84 ft. in height, with an allowable crown-block load of 120,000–180,000 lb. Most operators are using steel crown-blocks with cast-steel sheaves, although some still use wood crown blocks with cast-iron sheaves. Details of the rig and casings used are given.

Drilling costs—that is, labour, fuel water, and tools for drilling—are approximately $1/ft. The over-all dry-hole cost is approximately $1.25/ft. Average drilling speed is 100 ft./24 hr. As the cost and speed of drilling indicate, there are few problems in drilling in Central Ohio. Fishing jobs are largely confined to failure of wire and joints. Some difficulty is experienced in the top of the hole with caving. This can be materially helped by the use of Aquagel. The shell immediately above the Clinton sand caves very badly unless drilled with salt water. The wells are usually shot and produced against a back-pressure of one-third to one-half the rock pressure.

A. H. N.

697. Casing Recovery at Old Wells Conserves Steel for War Effort. H. F. Simons. *Oil Gas J.*, 18.6.42, **41** (6), 33–34.—Conservation of high-grade steel casing is necessary to provide steel for more essential war duty. Pipe for new wells can be obtained by reclaiming it from abandoned or uneconomic wells. This article describes recovery methods for long strings at Oklahoma City.

The amount of pipe which can be recovered from a well is principally dependent on the height of the cement behind it. Where casing has been set on a shelf, or with only a few sacks of cement in wells at Oklahoma City, it has been possible to recover the entire string. Recently on a Gulf Coast well over 8000 ft. of pipe was recovered.

The method used in this case was slightly different, an inside cutting tool being run in on a drill-string and a section of the casing freed by cutting. This section was then pulled by running a spear, after which another cut was made and another section pulled.

A. H. N.

698. Mud Control Saves Steel. Anon. *Oil Gas J.*, 14.5.42, **41** (1), 49.—In a very short paper is described how, with the present necessity for minimizing the use of steel in any form, mud engineers for some oil companies have accomplished remarkable results in eliminating long strings of casing by intelligent and skilful mud control, and by a willingness to spend an increased amount of money to carry out a suitable mud programme in order to effect a much greater saving. Examples are quoted. Such a case is: In one field in which wells are drilled to approximately 6500 ft., the following casing programme has been customary: 600 ft., 13⅜ in.; 5600 ft., 11¾-in.; 6500 ft., 9⅝-in. Native mud weighing approximately 82 lb./cu. ft. has regularly been used in these wells.

Recently in this field several holes have been drilled in which by using 98 instead of 82 lb./cu. ft. mud, about 5600 ft. of 11¾-in. casing has been eliminated. Careful mud control was maintained and a sufficient amount of colloidal clay added to keep the water loss and cake thickness at a minimum. Suitable chemicals were also used to further decrease water loss by keeping the colloidal material in dispersion, and to control viscosity and gel strength. The control resulted in saving approximately 140 tons of steel/hole, and, although the monetary saving effected was of less importance, the operator actually saved about $12,000. Not included in the above estimate of savings are costs which were also eliminated, such as for casing shoes, float-collars, cement, cement equipment, shut-off tests, extra rig time, and wear on wire line. Other examples are similar.

A. H. N.

699. Cheap Mud Work Employed in Drilling Trinidad Wells. C. N. Smith. *Oil Gas J.*, 28.5.42, **41** (3), 52.—This article describes some of the accomplishments possible through the use of modern mud-testing equipment used on wells in Trinidad, British West Indies, by the author. A testing kit, the same as that employed by many operators on deep wells in the U.S.A., was the basis for the work. Use of this kit resulted in a reduction of $11,000 in the mud costs for drilling 80,000 ft. of hole.

Various muds were tested to determine which gave the most desired characteristics. While searching for a cheaper viscosity reducing agent, tests were run on mud treated with citrus juice. The author describes the method of preparing the citrus juice, its application, and the results. A solution of 10% of pure citric acid is not as effective as the equivalent amount of lime-juice. Quebracho gives a much better reaction than pure tannic acid, both of which results suggest that it is not the acid content of these reagents which is of primary importance, especially in view of the fact that these reagents are equally effective when completely neutralized with caustic soda.

A very important economic point has been established—*i.e.*, that any grade or type of citrus fruit is useful for the preparation of this reagent; it does not even matter if the fruit is rotten, it still yields a reagent definitely better than quebracho and, of course, cheaper. Grape-fruits, lemons, shaddocks, and limes all have value, and this would certainly provide an outlet for all the low-grade fruit produced in the island. The significance of *p*H values of the mud is explained.

A. H. N.

700. Mud Control of Vital Importance to Drilling Technique. W. A. Sawdon. *Petrol. Eng.*, June 1942, **13** (9), 52.—A portable mud-testing laboratory is described. The apparatus includes a filter-press for determination of wall-building qualities and water loss, a *p*H meter, mud-balance and hydrometers, screens for cuttings and sand content, electric mixer, Marsh funnel, triple balance beam-scales, a shearometer, and equipment for analyzing for salt content.

The electric stove affords a means of testing viscosity, weight, gel strength, and water loss under various temperatures. New mud is frequently tested at temperatures as high as 170° F., as mud that reacts normally at atmospheric temperature may give a different reaction at hole temperature. The reactions obtained at various temperatures used in preliminary tests indicate what may be expected, and further tests made when the fluid is in circulation are performed at actual return temperatures. The mud during circulation does not attain bottom-hole formation temperature, and although there may be some heat loss before it reaches the surface, the temperature at the return is usually very close to that of the fluid itself when it is at the bottom of the hole, making routine tests performed at return temperature sufficiently accurate.

The procedure followed at the well where the laboratory is now in service required the taking of samples at stated intervals for routine tests. When the test indicates that chemicals should be added, allowances are made from the test data before using, as many factors are encountered while drilling that may have an influence on the mud fluid. Approximately one-half the amount of chemical is added initially, and another sample is taken at the end of the circulating cycle to determine what the effect of the chemical has been under down-hole conditions.

Tests are also made on the treated mud as it goes into the hole. The sample for this is taken just above the pump suction, as it is important to know exactly what is going into the system. Upon return of the treated mud another sample is taken, and whatever further treatment is necessary is indicated by this test.

Details and significance of various tests are reviewed. Advantages are discussed. Such an advantage is conserving casing steel. In one field where production is from depths of 9000 to 10,000 ft., an 8200-ft. string of 9-in. casing was eliminated and more than 900 ft. of 6⅝-in. string (usually run to below 9000 ft.) was saved. The weight of the mud circulated during the drilling of this well was from 90 to 92 lb./cu. ft., which was approximately the same as employed in previously drilled wells. More colloidal material was used, however, and chemicals were introduced to reduce the water loss. Other instances in another field are also cited. A. H. N.

701. Portable Steel Mud Flumes. Anon. *Oil Wkly*, 4.5.42, **105** (9), 83.—A California company is using highly unitized and interchangeable steel mud flumes which have a number of construction features. In addition to being easily moved from location to location and providing for the use of as many sections as necessary to design varied length of circulating systems, the sets have means of being connected in straight lines or for 90° turns, standards for constructing inspection walkways, facilities for cleaning and other features.

As the dimensions of each section are identical with others, as many may be used as are necessary to provide the desired layout. The type of material used in constructing the flumes consists of 2-in. pipe and several sheets of salvaged tank steel. The flume sections are constructed by first forming a substantial frame from the 2-in. pipe that consists of legs, side members, and top rails. These supporting frames are made up in standard dimensions, to provide interchangeability with other units. The construction of the flume is described in some detail.

For inspecting the flowing stream of drilling mud passing through the flumes, to make observation of make-up or dilution more convenient, and to keep the feet of the operators off the ground, sidewalks are a desirable part of the assembly. The supporting frame for the walks is made by using more of the 2-in. pipe, with sectional length sufficient to extend the full length of the flume section plus connecting attachments. The surface of the sidewalks may be finished with common dimension lumber wide enough in the aggregate to promote safety and utility. A. H. N.

Production.

702. How may Decline in Discovery Rate be Checked? J. L. Adler. *World Petrol.*, March 1942, **13** (3), 58–61.—The large majority in the oil-exploration industry are not yet convinced that geochemical surveys have shown a degree of infallibility which justifies appropriations at the expense of methods of proved worth. The search for stratigraphic traps has been strongly recommended, but of the larger ones discovered only a few are in the U.S.A., although many small ones have been found there. Moreover, the distinction between stratigraphic and other traps is not always clear. Indeed, many of the structural traps are dominated by stratigraphic conditions. It would be wise to consider the local structure in selecting locations for testing stratigraphic traps.

It would seem that the best way of increasing discoveries quickly is to maintain surface and subsurface geology, core-drilling, gravimeter, and reflection seismograph surveys at their present level, and then to drill on the numerous untested or insufficiently tested prospects which have been located during the last decade of geological and geophysical exploration.

These prospects have not been tested because of an attitude resulting from the economic depression of the thirties. Additions to already ample reserves were not essential, and dry holes were to be avoided at all costs. This attitude involving the search for greater certainties has led to many prospects being passed over. There is a need to return to the practice of testing all reasonable geological and geophysical leads. G. D. H.

703. Adequate U.S. Reserves Await Stimulation of Incentive to Drill. A. I. Levorsen. *World Petrol.*, March 1942, **13** (3), 44–47.—Estimates of available known U.S. oil reserves range from 18,000 million to 20,000 million brl., but only a quarter or a fifth of this is available for use during the next few years; the rest can be produced only at a progressively slower rate over a long period of years. The rate of withdrawal should not be such as will unnecessarily reduce the ultimate quantity of the known reserve. If the rate of production is to be expanded it is essential to discover new reserves.

The bulk of the current discoveries, as well as the most available undiscovered reserves, lie in areas of current development and production. Important reserves may be expected in the partly explored regions fringing the areas of current development. A third group of possible producing areas is farther removed from current development, and less is known about the geology of such areas than of the first two groups.

Areas in these three groups have thick, unmetamorphosed sediments, chiefly marine, evidence of oil and gas, regional unconformities and regional wedge-belts of porosity, all conditions common to most known oil provinces.

There are many possible producing provinces in the countries adjacent to U.S.A.

So many factors are involved in the formation of an oil-pool that almost every field differs from every other field. The conditions involved in the discovery of new fields are becoming more complex, increasing the cost of exploration. The results of many types of observations are now available to the geologist or other scientific

worker, but thought has not advanced sufficiently to make the fullest use of such results.

The small independent operator in U.S.A. has tended to discover the bulk of the new fields in the past few years, and the general absence of such operators in countries outside U.S.A. means that many areas in those countries which would be considered favourable in U.S.A. are unexplored.

A combination of liberal reasoning with the drilling of many slim-hole tests seems to be the best means of discovering new reserves. G. D. H.

704. Core Analysis—an Aid to Increasing the Recovery of Oil. J. A. Lewis. *Petrol. Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1487, 1–8.—In water-drive the homogeneous permeability of the sand and the thickness of the sand are the significant variables to be evaluated in order that the rate of intake of a given well may be determined. Rates of intake and rates of recovery calculated from core analyses for many different flooding operations agree well with the actual values from operating records.

It appears that the production of oil at economic rates by artificial water-drive takes place by positive displacement of the oil present in excess of the equilibrium saturation, substantially in accordance with the permeability of the sand to homogeneous fluid flow.

It is now possible to compute from core analyses the normal connate-water content of flushed cores from reservoirs under normal hydrostatic pressure to within 10–15% of the values obtained from tracer or oil-base mud cores.

From a knowledge of the reservoir fluid characteristics and the homogeneous fluid permeability of the sand, the productivity index of any point or zone in a sand-body may be calculated. The calculated and measured productivity indices agree closely. Since the permeability indicates the productive capacity, it becomes possible to compute the recovery to be expected from a volumetric or effective water-drive reservoir.

Field results and research show the existence of an equilibrium residual oil saturation after water-drive. By adjusting the production rates in potential water-drive fields so that a minimum drop in reservoir pressure results, or by artificially supplementing this water-drive by injection of extraneous water to maintain the reservoir pressure while obtaining profitable rates of production, it will be feasible economically to recover a larger portion of the original oil content. This technique, which would involve considerable water production in the final stages, should give two to two and a half times as much oil as would be obtained by normal gas expansion, and should be even better than the application of water-drive after the reservoir pressure has fallen to a low values. G. D. H.

705. Caliper Logging. C. P. Parsons. *Petrol Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1474, 1–8.—Caliper logging measures the variations in the diameter of the open hole in a well by means of four arms on apparatus which is drawn upwards in the well and gives a continuous record of the hole diameter. These caliper logs permit the calculation of the volume of cement needed in cementing operations, eliminating the uncertainty present when guesswork is necessary. They show that shales usually wash out considerably beyond the bit size, while oil-sands remain closer to the bit size. In gravel packing, a knowledge of the profile of the hole permits operations to be carried out which will make the placing of the gravel satisfactory. Caliper logs taken before and after acidizing show whether or not the acid is attacking some of the required places, and similarly the effects of shooting may be measured. In side-wall coring a caliper log will indicate the length of the mechanical core-takers which are needed. Seats for packers may be located by this form of logging, and the logs for several wells in an area provide stratigraphical information which can be correlated from well to well.

A number of caliper, electrical, temperature, and drilling time logs are included. G. D. H.

706. A Plan for Operation of the Paloma Field. W. H. Geis. *Petrol. Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1472, 1–6.—Soon after the discovery of the Paloma field it was realized that all the hydrocarbons in the reservoir were in the gaseous

phase, so that to obtain the greatest ultimate recovery of condensate the reservoir hydrocarbons must be produced in the single or gas phase. Consequently, the production engineers of the several companies concerned devised a plan for operating the field. It was contended that ordinary competitive production would give only 4000–5000 brl./acre against 21,000 brl./acre using pressure control. The plan proposed a central plant working at a predetermined practicable rate to give a 60° A.P.I. water-white product with 50% of aviation spirit, the residual gas being returned to the reservoir and finally extracted as dry gas. This plan would reduce costs and increase recoveries all round.

Some insisted that the specific relationship for each lease should be determined, a relationship involving area, sand thickness, porosity, permeability, saturation, structural position, and other factors, but the committee suggested participation on an acreage basis only. It was decided to put the operation of the plan under independent control, and the consulting engineers performed the technical work admirably, all efforts being made satisfactorily to fix the area for unitization. Nevertheless, the plan failed because a minority refused to accept the position of the boundary, and because of the possibility of a black oil-ring existing between the gas-cap and the edge-water.

An agreement was prepared, the details of which are briefly outlined, but it did not become effective because of difficulties on almost every point, with the lessors as much to blame as the operators. G. D. H.

707. Water Influx into a Reservoir and its Application to the Equation of Volumetric Balance. W. Hurst. *Petrol. Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1473, 1–16.—A method based on the classical diffusivity equation seems applicable to the calculation of water-drive relationships, and this theory has been successfully applied to the study of water movement at East Texas. The radial flow case of water-drive appears to be sufficiently accurate for most engineering purposes, but in the appendix the mathematical treatment is given of the linear, radial, and spherical cases of water influx into a reservoir.

In addition to establishing equations for the rate and total water influx, a method of solution is given for the case where the pressure–time curve may be represented by a series of straight lines. If the pressure–time curve is a smooth curve, there is no alternative but to resort to graphical integration.

An illustrative calculation is given, using the "broken-line" pressure variation, and the calculated relative water influx at various times agrees closely with the observed values.

None of the equations can establish the absolute water influx unless it is possible to fix the numerical coefficients associated with the integrals. In the determinations of the absolute water influx, the coefficients associated with the equations are established algebraically, together with the quantity of oil originally in place, by a solution of the volumetric balance equation for the fluids in the oil reservoir. G. D. H.

708. Development, Operation, and Valuation of Oil and Gas Properties. Part I. P. J. Jones. *Oil Gas J.*, 28,5.42, **41** (3), 45–47.—The first part of the paper deals with the porosity, specific permeability, and geometry of spacing of fields. Definitions of these and allied terms, together with the formulæ used in their calculations from test data, are given in short paragraphs. A method of getting the effective radii of wells in random spacing patterns is given. For this type of spacing the boundaries of the acreage from which a well is producing in the absence of fluid migration is a polygon formed by the intersection of the perpendicular lines through the midpoint of the lines radiating from a given well to the surrounding wells. The area of each polygon may be planimetred, or each polygon may be subdivided into triangles, and the area of each triangle computed from base and altitude measurements. Then the following equations may be used for determining the effective radius:

$$a = \frac{0{\cdot}866D^2}{43{,}560}$$

and

$$R = 0{\cdot}595D$$

where a = acreage allocated to a well; D = distance in ft. between wells in a row; and R = effective radius in ft. A. H. N.

709. Proper Production Methods. R. O. Garrett. *Oil Gas J.*, 7.5.42, **40** (52), 56–57. *Paper Presented before Natural Gas Section, American Gas Association.*—The paper deals with gas-production methods from prolific and high-pressure reservoirs from a depth of 5000–7000 ft., pressures ranging from 1500 to 3000 lb./sq. in. at the surface, the gas having a considerable fluid content of 5–20 brl./1 million cu. ft.

The general plan of operation after the well is properly completed is to test it for open-flow capacity, following in general the Bureau of Mines method of back-pressure testing as described in Monograph 7. Care is maintained at all times to ensure that each rate of flow is thoroughly stabilized. If stabilization is impossible, due to fluid content or other factors which render surface pressure unreliable, it is necessary to run a sub-surface pressure instrument into the well and obtain pressures by that method.

Such tests are repeated at quarterly or half-yearly intervals, so that availability and reserve studies may be made.

Wells which do not tend to freeze through the formation of hydrates are controlled through surface chokes, and wells showing a tendency to freeze up are controlled through the use of regulators.

Where wells are completed sufficiently far above the gas–water content to minimize the danger of coning and channelling of water, they are produced at a sufficiently high rate of flow to prevent freezing for a period of a few days, and are then closed in for the remainder of the month, while other wells are turned on in a similar manner, to provide a continual flow of gas to the pipe-line; this, of course, is possible only where well capacities greatly exceed pipe-line requirements.

Details of mainfolding are given. A. H. N.

710. Calculation of Back-Pressure Tests. J. W. Ferguson. *Oil Gas J.*, 7.5.42, **40** (52), 52.—Tables are given for use in calculating back-pressure tests on wells having GL values up to 7000 and equipped with any standard casing or tubing size, where G = gravity of gas and L = length of column. The formation pressure P_f may be obtained by the equation $P_f^2 = e^S Pc^2$, in which Pc is the shut-in rock pressure at the wellhead, lb./sq. in., absolute, and e is the base of natural logarithms, 2·728 . . . , S is a symbol to represent the value of $S = \frac{2GL}{53{\cdot}34T}$, in which G is the specific gravity of the gas, L is the average depth of gas pay in feet, T is the absolute flowing temperature of the gas in the producing string.

Values of e^S corresponding to various values of GL may be found in a table given in the paper. Once obtained for a well, this factor remains constant, depending, as it does, only on the GL of the well and the flowing temperature, which is assumed to be constant.

Formulæ and a table are given for calculating sand-face pressure during flowing conditions, utilizing a simplified form of Weymouth's formula to calculate the frictional head. A. H. N.

711. Oil-Well Pumping Tests. H. E. Dralle and E. H. Lamberger. *Oil Gas J.*, 7.5.42, **40** (52), 43.—Describes some results of comprehensive and exhaustive tests on pumping wells undertaken by the Phillips Petroleum Co. The full results of the tests are so far-reaching and cover so many phases of oil-well pumping problems that their ultimate value cannot be immediately utilized. So far, the most obvious benefit seemed in the direction of proposing to the A.P.I. special subcommittee on well-load formulæ more accurate formulæ for calculating from known well conditions, peak polished-rod loads, pump plunger stroke, and peak crankshaft torques. Solutions seem possible for such other problems as predetermining prime-mover horse-power from the hydraulic horse-power, optimum counterbalancing, and the true relation between loads at the polished rod and at any other point in the mechanical system on the pumping well.

Figures given illustrate the locations and types of the many strain-gauges used and the type of results obtained. One figure shows oscillographic recording (two oscillographs, each with nine elements used) of the following: (1) Load in string immediately above the pump. (2) Load in rod-string at mid-point between pump and polished rod. (3) Load in polished rod (Jones dynamometer). (4) Dis,placement of polished rod. (5) Tubing load. (6) Deflection of walking beam forward

from sampson post bearing. (7) Deflection of walking beam to rear of pitman bearing. (8) Load in pitman. (9) Torsion in low-speed shaft of speed reducer. (10) Rotational displacement of low-speed shaft of speed reducer. (11) Prime-mover speed. (12) Electric-motor voltage. (13) Electric-motor current. (14) Electric-motor power input. (15) Timing record.

Besides these fifteen simultaneous recordings, the following accurate readings, timed for a particular test, were obtained: (1) Motor-power consumption (watt-hour meter). (2) Pumping speed (s.p.m. obtained with stop-watch). (3) Volts, amperes, and power consumption (graphically recorded by voltmeter, ammeter, and wattmeter respectively).

The various types of instruments and other equipment are briefly described. Test procedure is similarly outlined. An attempt was made to hold the total time/test to a minimum—5–10 min.—so that fluid level in the well would not be appreciably affected. The various conditions under which tests were made include the following: (1) Three plunger conditions: 1¼-in. plunger, 1¾-in. plunger, and 1¼-in. plunger without travelling valve. (2) Two tubing sizes: 2½-in. and 3-in. (3) Rod-strings with all standard couplings, with alternating spiral and standard couplings, and with all special couplings. All tests were made with ¾-in. rods. (4) Beam and rotary-type counterweights, separately and in combination. (5) Three prime movers: two electric motors and one engine. (6) After a few tests at 4500-ft. depth, the pump was set at 3500 ft. for the remainder of the programme. (7) Forward and reverse crank rotation. (8) Short tests of many normal operating conditions. (9) Long-period tests under normal operating conditions to compare performance of two types of electric motors. (10) Shock and friction tests to study and secure data for determining the over-all damping factor of the well.

Only a few results, however, are given. A. H. N.

712. Central Hydraulic Pumping Used in Hull-Silk Field. T. P. Sanders. *Oil Gas J.*, 7.5.42, **40** (52), 41–42.—The central hydraulic pumping systems at Hull-Silk are distinctive in that the wells are pumped with their casing-heads closed. All gas produced with the oil passes through the pump and up the tubing to reach the surface. Since expansion of gas in the tubing reduces the weight of the fluid column, there is a corresponding reduction in the power-fluid pressure that must be used in the pumping system.

Another unusual feature found in both the Hull-Silk and K.M.A. fields is the equipping of many of the wells with hydraulic pumping equipment before natural flow ceases. This is done for two reasons: (1) the early installation of subsurface pumping equipment avoids the possibility of losing production during the final stages of uncertain flow, and (2) the producing gas–oil ratio can usually be lowered sufficiently to avoid the production penalties applied in this area against inefficient use of gas.

The penalty for excessive gas–oil ratio takes effect on wells which produce more than 2000 cu. ft. of gas/brl. of oil. Throughout most of the average well's flowing life it is not difficult to regulate the production rate in such a manner that penalty will be avoided. However, during the last stages of flow it is not unusual for gas–oil ratios to rise to 4000 cu. ft./brl., in which case the excessive gas–oil ratio penalty involves one-half of the well's normal allotment.

With casing-head connection closed, Hull-Silk casing pressures are found to vary from 100 to nearly 800 lb. while the wells are being pumped. In some wells of the K.M.A. field it has been found necessary to install regulators on the casing-heads that will allow a small amount of gas to bleed off while the well is being pumped, thus providing enough differential to keep oil coming into the hole. It is believed that this practice will be found necessary at some of the Hull-Silk wells.

Details of mainfolding are given. A. H. N.

713. Development, Operation, and Valuation of Oil and Gas Properties. Part 4. *Oil Gas J.*, 18.6.42, **41** (6), 35.—This part of the paper deals with the flow of homogeneous fluids, and in particular of water in virgin oil and gas-pays. The water content of hydrophylic oil and gas-pays prior to any advancement of bottom water or edge-water may be classified as (1) trapped water, (2) absorbed water, and (3) capillary water.

The significance of these waters is explained. Physical properties of sands are discussed. Interfacial tension and its effects on the problems of water in sands are studied. Interstitial water and its effects on recovery are mentioned and briefly studied. A. H. N.

714. Proper Oil Prolongs Life of Pumping Unit Speed Reducer. K. N. Mills. *Oil Gas J.*, 30.4.42, **40** (51), 161.—Correct use of the proper oil prevents excessive wear, overheating, and protects the parts from rust. In performing these duties the oil used must withstand high unit loads while continually subjected to oxidation by aeration, and perhaps also while exposed to atmospheric moisture and corrosive gases. Likewise, it is called on to give effective lubrication within extreme temperature ranges.

As the oil in a reducer is very thoroughly aerated, it is reasonable to expect the oil in a reducer operating in a sour-gas area to absorb some of this corrosive gas. This corrosive gas will act on the bright metal parts of the reducer, and will form a metallic oxide on the bearing parts. If the contamination of the oil by the sour gas is sufficiently high, it will cause the bearings to fail by abrasive wear. The author has had several oil samples from reducers which are operating in sour-gas areas analyzed to determine their acid content. Some of these samples were found to contain about seventeen times the maximum allowable amount of acid for a satisfactory roller-bearing lubricant.

Corrosion can also be produced by water in the oil, and water will enter the reducer with the air drawn into the reducer during its breathing action. This moisture condenses on the inside of the reducer, and mixed with the oil when the reducer is in operation. In damp sections of the country a surprisingly large amount of water enters the reducer in this manner. As water causes rust, and rust is an abrasive, this water may also cause excessive bearing wear. The corrosion resulting from this condition is probably the most destructive, because of its dual nature. The rust that it produces flakes off the parts on which it forms and is suspended in the oil. As this rust enters the oil, it is circulated through the bearings and causes abrasive wear. This action not only exposes the bearing to wear from abrasives formed on the bearing parts, but also from the abrasives formed on the other steel parts of the reducer.

Use of mineral oils and the care to be taken are discussed in detail. A. H. N.

715. Value of Sound Pump Practices Increased by Emergency. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 136.—Oil producers will be obliged to use pumps made of less steel in order to produce more oil for the all-out war effort. Here are some of the specifications thought to be contributory: (1) One-piece alloy steel barrel. This will reduce bulk and can be rehoned repeatedly for long wearing life. (2) Special "heat treatment" applied to barrel. This step hardens the steel so that the barrels give two to five times the ordinary wear. (3) Precision-aligned barrel. Straight barrels will reduce pump wear. (4) Mirror-finish honing of wearing surfaces of barrel. Precision honing provides for smooth plunger operation. (5) Hard-metal plungers. Hardened and honed barrels must be fitted with metal plungers, equal in abrasion and corrosion qualities to the barrels. Such a combination results in minimum wear. (6) Uniformity of standards and measurements. Barrels, plungers, fittings, and even the elements which make up these items will require precision measuring instruments for control of every detail in the pump's design and construction. (7) Stroking through barrel. By arranging the stroke so that the plunger can stroke through the entire barrel, projecting at both ends, the barrel can be made to wear evenly so that an oversize plunger can be run without first rehoning the barrel.

Different types of pumps and their components are described. Care in transportation is discussed. Stroke lengths and frequency should be adjusted to the maximum desired recovery without "pumping off." The latter not only tends to bring sand into the well, but between heads permits the sand in the oil in the tubing to settle back on the plunger, and may cause scoring and sticking of the plunger. Pumping wells too fast often increases gas–oil ratio and causes water-coning of the sand. The rate of pumping should be adjusted to the ability of the sand to produce under the pressure of a uniform edge-water drive. Long, slow strokes best provide

this condition when viscous oils are pumped, and also reduce the tendency for viscous oils to emulsify.

The pumping stroke should be adjusted to space the working and standing valves as closely as possible, without actual contact. This is particularly important for wells where gas is a factor.

In metal-to-metal pumps, the plunger fit is highly important. This must be balanced to suit all conditions, for maximum efficiency. If too tight, there may be excessive friction due to lack of space for proper lubrication, and the plunger may not drop freely enough to keep pace with the stroke. If too loose, excessive slippage may occur, particularly in higher gravity fluids. Fine sand is better handled with plungers which are not too loose. No specific rules for establishing proper plunger fits can be stated. Usually, nothing tighter than minus 1 is desirable, except under extraordinary conditions. By the same token, specific well conditions, particularly with fluid of extremely low gravity, may occasionally require the use of fits such as minus 11. Minus 1 to minus 5 may be said to represent the average range.

Dismantling, inspecting, and reassembling pumps are discussed. Stainless steel, with its 17% chromium content, requires special precautions to avoid undue wear and to make reclamation possible. Use of a neoprene packer is the only major difference between casing pumps and tubing pumps. The following precautions should be taken against tearing up the packer when the casing pump is being removed from a well: (*a*) Use only enough pulling force on the rod-string to remove the mandrel from the packer, then allow the well to stand idle for a few minutes until the back-suction has stopped, indicating that the column of fluid above the pump has equalized with the fluid pressure below the pump. Next, reseat and unseat the mandrel in the packer several times with a pumping motion. This will jar the packer, freeing the packing element from the walls of the casing and allowing fluid to pass down around the pump. The pump can then be pulled without having the packer act as a swab. (*b*) Casing pumps are usually set on slips. When this is the case it is recommended that the pump be moved up or down the hole a few feet whenever the pump is unseated for any reason. This prevents the slips from setting to the casing because of corrosion. A. H. N.

716. Suggestions for the Saving of Steel for the National Effort. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 146.—Using the 1¼-in. hemp centre-grade "J" line in a 136-ft. derrick, it is possible to get approximately 10 ton miles/ft. of rope purchased, or 27,500 ton miles for a 2750-ft. length and, excluding unusual conditions, should be considered the average rather than the exception. This is accomplished by moving the line off the standby to the hoisting drum in 10–15-ft. increments every three to five round trips, depending on the weight of pipe used, and cutting off the accumulation on 100 ft. pieces. When rope becomes too short for further movement, it should be run to destruction. Studies are given of the wear rate of chains.

Saving in steel can be made through the maintenance of equipment larger than formerly, even though it be beyond the economical limits. It is common practice to re-sleeve drill-pipe tool-joints to extend their life, and, in the case of the integral joint, the pipe itself. Drill-pipe life may be further extended by replacing worn-out integral joints by the welding method. Also short wear collars may be installed on the middle body of the pipe. Drill-collar ends may be repaired in the same manner and, when the body becomes worn from formation, half-circle segments about 18 in. long may be welded together to form a new case.

In many deep California fields much drill-pipe is discarded prematurely because of failures due to slip-wear. Investigations are now being conducted as to the possibility of utilizing elevator-type slips to offset this condition. The life of drill-pipe can doubtless be greatly extended in this manner. Some companies have an arbitrary figure of $\frac{1}{8}$ in. which the wear of a fluid piston rod shall not exceed. Since the rod is ample in strength, it should be run until "bottle-necked" to such an extent that it will no longer hold packing, which on a 2½-in. rod will be found to be about ½ in. A. H. N.

717. Abuse Shortens Life of Rods and Couplings. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 132.—In the case of a relatively deep well, where corrosion may be encountered, it is not practical to select a rod without exceedingly high physical properties and

which is designed for these corrosive conditions. In a shallow well where exceedingly large bore-pumps are operated on short, fast strokes (with consequently heavy shock loads), it is not practical to install a rod that does not have the greatest ductility and impact resistance. On the other hand, it is not practical to use high-strength, alloyed rods for shallow stripper wells where very little impact is occasioned or where no corrosion is in evidence.

Size of rod is governed by highest peak load under which it is expected to operate, and also what portion of that load is released on the downstroke. In the deeper wells a combination string of rods may be required. This combination string may consist of two or three steps in rod sizes, of which there are 1-in, ⅞-in., ¾-in., and ⅝-in. rod diameters.

Where this combination string is used it is extremely important that the proper proportions are used to obtain the best service life. These proportions will vary with each bore of pump, regardless of the depth at which they are operating. For a well-balanced string the maximum stress in lb./sq. in. should be practically the same on all sizes in the combination. However, the allowable stress in lb./sq. in. will vary somewhat on each rod size, inasmuch as it is necessary to consider the fluctuating stress (or stress range) to arrive at the maximum allowable stress on each size.

Examples of, and precautions against, mishandling sucker rods in transportation, storage, and installation are given. After the installation is made, it is advisable to weigh the well in order to determine proper amount of counterbalance. At the same time it is possible to regulate the length of the stroke and strokes/minute to that point where the smoothest operation and most economical production may be maintained.

Where a pump has become sanded up, or when it is necessary to pull the pump for any other reason, it is highly important that too much pull is not put on the rods in an attempt to dislodge the pump from the sand or from the hold-down. In the event of the rods being stressed over the yield point irreparable damage may be caused to that particular string, and the company still has a difficult problem.

As the rods are removed from the well and the joints are broken, under no condition should the couplings be hit with a hammer or any metal object, in order to help free the tight joints. This results in fracturing the hard case on the couplings and, consequently, when the rods are run back into the well, fatigue failures occur in the couplings due to the concentration of stress in these fractured areas.

Suitable hangers should be used. A. H. N.

718. Proper Practices Extend Useful Life of Sucker Rods. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 126.—The most important factors to consider in obtaining the maximum service from sucker rods may be roughly divided into three groups: (1) Proper selection of type and size. (2) Proper methods of transportation, warehousing, and installation. (3) Proper mechanical operating conditions both in surface and subsurface well equipment. These are explained. Proper transportation and handling of sucker rods are detailed.

A pump which is not filling properly or which is too large for the rods and pumping unit will overtax these other pieces of equipment, and trouble will develop. Conversely, a string of sucker rods that is too small for the pump and unit will cause trouble and reduce the amount of effective work done by the other two. Consequently it is well to see that the various parts of the entire beam-pumping installation are in balance with each other.

Two of the most common causes of sucker-rod trouble are overload and low pump efficiencies. Overload usually makes itself apparent by sucker-rod failures in the top section of the string of sucker rods. The remedy lies in reducing the speed of operation or length of stroke, or both, reduction in the pump plunger size, or increase in the size of the sucker rods. Productive capacity of well, state proration laws and the economics of the case should indicate the action to take in reduction or elimination of this condition.

Low pump efficiencies and sucker-rod trouble usually go hand in hand, and this is one of the most common sources of grief to the sucker-rod user. With many wells it is not possible, with present equipment and well hook-up, to take an individual production gauge, and it has frequently been found that a well is being produced

with a pump several sizes too large for the amount of fluid. It is impossible to calculate the efficiency of the pump unless total production figures are known. Where individual well tankage is not permanently installed on the lease, a wise procedure is the use of a portable test tank for the taking of individual well-producton gauges at frequent intervals.

A useful piece of equipment for the production engineer is a polished-rod dyanmometer or well-weighing instrument. Frequent use of this instrument on beam-pumping wells will reveal most of the common causes of sucker-rod failure, and preventive measures can be taken in advance of the actual trouble. Keeping accurate sucker-rod service records is an absolute necessity if the best performance is to be obtained from beam-pumping installations. Through a careful day-by-day study of such records a number of producing companies are effecting annual economies running into thousands of dollars through sectional replacements of sucker rod-strings alone—in other words, replacing only those portions of the rod string where trouble is being experienced rather than replacing the whole string. A. H. N.

719. Chemicals Play Important Rôle in Maintaining Equipment. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 106.—Chemical effects in acid treating of water-disposal wells is illustrated graphically. Scale solvents, which contain appreciable amounts of inhibited hydrochloric acid, are used extensively for the purpose of removing nearly every kind of scale accumulation from the cooling systems of internal-combustion engines and compressors. This method of improving the efficiency and lengthening the life of the equipment is economical, easy to apply, and effective in every part of the equipment where the scale accumulates.

Ordinarily, the inhibited acid is merely circulated through the system until the scale is removed. Shutdown times are thereby reduced to a minimum, because it is not necessary to dismantle the equipment in order to remove the scale deposits by this method.

These solvents, the composition and concentration of which are frequently changed by the addition of various agents, for the purpose of securing maximum scale-dissolving properties, are also being widely used by refiners for the removal of acid-soluble chemical deposits found in condensers, heat exchangers, absorbers, evaporators, vacuum towers, and steam boilers. In the past the standard scale-removal practice has been by mechanical methods. However, due to improvements in chemical treating and rapid analysis of the scale by X-ray methods and the compounding of chemical mixtures based on the chemical analysis, serious delays in production schedules, costly shutdowns for repairs, and subnormal efficiency with its resultant higher operating costs have been largely obviated by chemical removal of the scale in refinery equipment, natural-gasoline plants, booster stations, and miscellaneous pumping and cooling equipment. A. H. N.

720. A Note on Conservation. E. L. DeGolyer. *Petrol. Engr*, June 1942, **13** (9), 58–59. *Paper Presented before American Petroleum Institute.*—A plea is made for conservation methods and the avoidance of waste both below and above ground. As an example, the author quotes the production practices in two fields—Hobbs, New Mexico, and Tinsley, Mississippi. Each field extends over about the same area, approximately 10,000 acres; although, owing to differences in the thickness of the producing zone, Hobbs was estimated to have about twice the recoverable reserve of Tinsley, with both fields produced under good practice. Each field had substantial water drive. Hobbs was produced slowly enough to allow it to be effective, and Tinsley at much too rapid a rate to allow the water drive to be effective.

Hobbs had an original bottom-hole pressure of 1550 lb./sq. in., approximately 263 producing wells, and after approximately 13 years had produced half its reserve with a loss of less than 400 lb./sq. in. bottom-hole pressure, and 85% of its wells were still flowing. Tinsley had a higher bottom-hole pressure, some 1850–1900 lb./sq. in., approximately 327 wells, and after less than 2½ years had produced a probable third of its ultimate recoverable reserves with a loss of more than 1000 lb./sq. in. bottom-hole pressure and with none of the wells in the main sand still flowing.

The conclusion is reached that in spite of the fact that no two oil-fields are comparable, the disparity in the performance of the two fields is so great that much of

the difference is due to the different production practices. Stress is laid on the excessive production of gas in present-day practices. A. H. N.

721. Repairing Casing Leaks. F. J. Spang. *Petrol. Engr*, June 1942, **13** (9), 35.—The paper deals mainly with problems encountered in old fields, and deals with several methods used for removing and replacing a leaky joint by a joint of good casing. The first step in preparing the job for casing repair is to set a removable bridge either in the casing below the leak or, preferably, in a solid, hard-walled portion of the open hole below the casing seat, in a spot that would not expose a formation likely to cave during the repair job. The bridge may be started by using a small forked tree or bush centre. Sufficient burlap sacks to make a temporary support are placed on top of the bush, and sand pumpings and clay are then dumped above it in sufficient amount to prevent leakage through the bridge; or the bridge may be of a mechanical design.

When the bridge is set and the hole made tight by sand pumpings and clay, the hole should be baled out and a casing tester run to find the leak and determine its volume. A casing tester may be made of 1-in. or 1½-in. pipe 2 or 3 ft. long. The top of the pipe should be threaded about 4 in. A casing size leather, rubber disc, or diaphragm is fitted between two metal washers slightly smaller than the casing and held in place on the pipe by means of two pipe-size lock-nuts. A tee with the opening at the side is screwed on to the thread above the diaphragm, and a bail screwed into it. The lower end of the pipe is capped. The casing tester is run on the measuring line. The leak is found by running to different depths until found. Unless previously known, the volume, if rather large, is measured by gauging the fill-up time in the hole or bailers/hr. If rather small it can be gauged by the tester.

After testing, the hole is filled to the level of the leak, or a little above it, before removing the casing. Several methods are described.

The use of a trip-spear to free casing by successive jarring and tripping is described in detail. This method of establishing the free point of the casing and setting the spear for action just below it in a tight or frozen area lessens the likelihood of damaging the casing or couplings by excessive jarring at a point below where the casing is tight. Obviously, if considerable jarring were done at a point where the casing were free, and this point was below the tight point, there would be danger of injuring the casing at the point where the trip spear had its hole, or loosening or damaging the couplings above it.

By following this procedure, the casing will be loosened through each tight point, and the jarring action, even though moderate, will tend to loosen the sediment behind it. Thus, the stress taken at the surface may pass downward through the casing to a lower point each time an upper point is freed, thus aiding in greater degree as greater depths are reached.

Once the free point is found and the spear lowered each time the casing report is felt at the surface, some additional stress may be imposed on the casing at the surface. In other words, if 100 ft. of casing has been freed from the wall sediment, then 100 ft. of casing is ready to absorb its share of surface stress. This procedure, if carefully followed, will generally free any string of casing. A. H. N.

722. Lower Production Costs Through Advance Lease Planning. G. M. Wilson. *Oil Wkly*, 11.5.42, **105** (10), 22–25.—The planning for lease development of a California company is described. Long before drilling was started, the lease was laid out in a row pattern, and the gathering-line system, following the same pattern, has greatly aided in lowering both drilling and the subsequent production installations and maintenace costs.

While the drilling programme is not yet completed, and, in view of restriction being place on drilling, might not be completed for several years, the production facilities have been exceptionally well planned and laid out, and centrally located with a view to efficiently handling all the wells when they are finally drilled, with little work or enlarging of the present facilities.

In addition to the efficient gathering system, which incidentally does not include any small gauge-tanks, the company has installed a centrally located three-unit hydraulic-pumping plant that pumps fourteen wells. Low-cost maintenance and ffiecient operation of this plant are due in great measure to a specially designed

combination power-oil and head-exchanger storage tank that utilizes engine-water heat to heat the oil, and at the same time, in so doing, cools the engine circulating water. The system is provided with means whereby any degree of heating or cooling is possible merely by turning of valves to divert the flow of engine-water through various parts of the system.

Production is from three zones. The development pattern was arranged as nearly as possible in north–south rows, approximately 400–500 ft. apart, and with each row containing from six to eight locations. Each location consists of from one to three single-zone wells spaced anywhere from 100 to 200 ft. apart. No two wells in a given zone are closer than 450 ft. The pattern is discussed. Engineering details of the gathering system are given.

Smooth, trouble-free functioning of the centralized hydraulic-pumping plant is a factor contributed in a large degree by a fully automatic heat-exchanger system that uses hot engine-water to heat the hydraulic power oil, and simultaneously causes the circulating water to become cooler by reason of its having given up its heat to the oil.

The hydraulic-pumping plant consists of three multi-cylinder gas-engine-driven triplex power units, housed in a 20- by 35-ft. sheet-iron building. As more wells go on the pump, plans long since worked out will permit the building to be expanded to accommodate four more units. Present piping, power-oil, and cooling facilities are designed for an ultimate of seven units. Each unit can handle six wells without danger of overloading. The system is discussed in some detail. A. H. N.

723. Return of Surplus Gasoline to Sands Being Considered. Anon. *Oil Wkly*, 4.5.42, **105** (9), 81.—Due to war-time demand for special products while normal civilian consumption declines, use of depleted oil reservoirs as storage basins for large stocks of finished low-grade gasoline piling up in California and Texas is being studied. Storage facilities for low-grade gasoline are being jammed, and within a few months the surplus may become so great that the product will either have to be destroyed or some revolutionary storage means developed. Priorities on steel for tanks are out of the question.

Therefore, many foresee the possibility of meeting this threatened crisis by pumping the gasoline back into depleted zones in old fields. Due to the great demand for fuel oil, some refiners may start burning gasoline under their boilers so as to dispose of it and save fuel oil at the same time. The situation is of grave concern, for refiners must continue operating to provide the necessary war products, and in doing so necessarily manufacture considerable quantities of low-grade gasoline for which there is a reduced need.

Previous experiments and experiences are given. If the period of low-grade gasoline over-supply is to be extended, it would appear that a number of economies could be effected by the use of old fields as storage basins for the surplus products. Several necessary items of expense incurred in surface storage could be eliminated. These would include insurance, taxes—both on the product and any surface facility in which it would otherwise be contained—and elimination of evaporation losses and losses from leakage.

Opposed to these advantages are also some disadvantages. A primary disadvantage lies in the fact that it costs money to put oil or gasoline into the formation, and would cost more to pump it out again. There is also a possibility that the product returned to the sub-surface reservoir may never be recovered, although Union Oil Co. engineers can see no reason why it cannot all be pumped out again—with the added prospect that a considerable volume of the original oil in place of heavier gravity may be subject to recovery when broken down by lighter fluids.

Important factors in estimating cost per brl. for such storage would be decided both by the volume of fluid for which storage is needed and the length of time such fluid is left in the storage basin. In the matter of taxes alone, for example, if it is left on the surface, the tax charges would eventually equal the original value of the products. Evaporation and leakage are also important considerations in surface storage over long periods. A. H. N.

724. Arkansas Contributes Much to Sound Conservation Methods. G. B. Nicholson. *Oil Wkly*, 11.5.42, **105** (10), 15–19.—With the development of knowledge of conserva-

tion methods, Arkansas stands among the most prominent advocates of practices for receiving greatest benefit from natural resources. At present the State, together with its valuable contribution to the oil and gas and condensate reserves of the U.S.A., also sets an example by furnishing outstanding methods of conserving these vital petroleum products. Well-regulated schedules of allowables for oil- and gas-wells are determined by engineers of the Arkansas Oil and Gas Commission after detailed field engineering tests are made, and enforcement of rules assigned to fields and wells is a foregone conclusion. Complete and detailed records are available in the commission offices, giving up-to-date reports on all fields in the State, and variations in these reports, which are frequently compiled, furnish specific knowledge of field and reservoir trends.

The oil industry in Arkansas represents minimum waste of natural resources. Proration and allowable schedules are designed to provide the greatest ultimate recovery of oil and gas, and there is little waste of these products in the drilling, completion, and producing of wells, or in the manufacture of by-products. While in many other oil-producing States venting to the atmosphere of casing-head gas containing hydrogen sulphide is not regarded as waste, it is in Arkansas, and for that reason a new industry is coming to life, consisting of removing hydrogen sulphide from gases produced in Southern Arkansas, fitting the sweetened gas for domestic or industrial services, and separating the sulphur for industrial use.

One of the most interesting procedures, and one on which considerable emphasis is being place in Arkansas, is installation and operation of repressuring projects. The large Schuler plant has now been completed long enough to show decisive benefits. This plant, a million-dollar project including pressure-maintenance and gasoline extraction units, was placed in operation in the early part of 1941, injecting gas into the Jones sand, one of three producing formations in the big field.

With virtually all gas produced from the Jones sand now being returned to the formation, the early rapid decline in bottom-hole pressure has virtually ceased. Besides the gas actually removed from the producing horizon, additional gas is being brought in from the Village, Atlanta, and Magnolia fields, and is injected into the Jones sand as part of the pressure-maintenance system. The pool continues to produce 13,500 brl. daily from this sand, according to the latest Oil and Gas Commission reports. Plans for launching a second project are being made. Sour gas conservation is also practised. Desulphurization plants are designed to separate hydrogen sulphide in a liquid form, and it is planned that this by-product will be utilized by the chemical industry. Carbon dioxide will also be removed from the gas, and it, too, will find its place in industry. The manufacture of butane and propane to supply the consumer with gas beyond the ends of gas line has become commonplace, with several gasoline and butane plants already operating, one of the finest and largest field plants operated by Shell Oil Co. in the Magnolia field.

The paper includes development and production data for Arkansas. A. H. N.

725. Petroleum Engineering. Part 4. L. C. Uren. *Petrol. Engr*, April 1942, **13** (7), 76.—In this part of the paper various colleges, universities, and institutions which give courses in petroleum engineering in the U.S.A. are studied, together with the requirements of such institutions to be efficient and effective in imparting the necessary training to engineers. A. H. N.

726. Petroleum Engineering. Part 6. L. C. Uren. *Petrol. Engr*, June 1942, **13** (9), 86.—In this part several more American universities and colleges which cater for petroleum science are described. A. H. N.

Transport and Storage.

727. Soil-corrosion Studies, 1939. Coatings for the Protection of Metals Underground. K. H. Logan. *Bur. Stand. J. Res., Wash.*, 1942, **28** (1), 57–71.—The condition of specimens of metallic and non-metallic coatings after exposure to soils for periods ranging from 2 to 16 years is reported in this paper. Specimens of metallic coatings applied to both sheet and pipe were exposed to soil corrosion at forty-seven sites in 1923 and 1924, while further series of tests were installed in 1932 and 1937 at an

additional fifteen sites. Ten specimens of each coating were buried at each site, two samples being removed at each inspection.

The non-metallic coatings started in 1924 were applied to steel pipe, and five specimens of each coating were buried at each test site.

Conclusions previously reached regarding the protective value of zinc and lead coatings have been generally confirmed by the latest inspections.

The protection afforded by zinc coatings depends on the thickness of the coating and it has been found that uniformity of coating is important.

Lead coatings applied to iron and steel have not proved adequate for protection underground. The potential of lead is cathodic to iron, so that this metal cannot protect in a manner similar to zinc.

Tin coated copper is corroded in soils which corrode copper.

As regards non-metallic coatings, after 15 years' exposure to soils two hot-dipped asphalt and coal tar coatings have failed. A group of experimental vitreous enamel coatings and two hard rubber coatings exposed 7 years have so far afforded complete protection.

In a 2-years' exposure test a Bakelite coating consisting of several coats of varnish, each coat being baked on, has afforded the most satisfactory protection. Air-dried Bakelite coatings blistered somewhat and allowed some rusting, but severe corrosion under these coatings occurred only in cinders. D. L. S.

728. Soil-corrosion Studies 1939. Ferrous and Non-ferrous Corrosion-resistant Materials. K. H. Logan. *Bur. Stand. J. Res., Wash.*, 1942, **28** (3), 379–400.—Corrosion data are presented for the third of a series of five inspections which are made at approximately 2-year intervals. The chief departure from earlier reports consists in the presentation of the data for loss of weight as well as for maximum penetration as total loss per unit area and total pit depth rather than as rates. Since the primary purpose of this investigation was to determine what metals and alloys are most corrosion-resistant in different corrosive environments, the corrosiveness of the soils was an important consideration in the selection of sites for the field tests.

A table indicates the nature of the soils, physical and chemical properties being given. The composition of the metal specimens, which included cast iron, wrought iron, carbon steels, alloy iron and steels, copper and copper alloys, zinc, and lead, are also shown.

Results obtained so far show little difference in the corrosion resistance of the wrought iron, low carbon steel Cu–Mo open-earth iron, or steel containing 4–6% chromium. By increasing the Cr and Ni contents, ferrous metals may be made highly resistant to soil corrosion.

Except in one type of soil, the corrosion rate of Cu–Zn alloys increased generally with the zinc content. As regards zinc and lead-alloy specimens, the former behaved similarly to the ferrous metals, whilst lead was attacked in acid organic soils.

However, since a large proportion of the soils to which the specimens were exposed were very corrosive, the failure of certain materials does not necessarily reflect on their usefulness for moderately corrosive soil conditions. D. L. S.

Cracking.

729. Patent on Cracking. R. F. Ruthruff. U.S.P. 2,278,590 7.4.42. Appl. 20.10.39. Conversion of higher-boiling hydrocarbons to hydrocarbons of lower boiling point by vaporizing the former and passing the vapours in contact at a cracking temperature with a magnesium silicate pseudomorph of calcium silicate. H. B. M.

Hydrogenation.

730. Patents on Hydrogenation. W. F. Huppke. U.S.P. 2,279,198, 7.4.42. Appl. 18.1.38. Catalytic conversion of hydrocarbons involving subjection of hydrocarbon gases and vapours to a conversion temperature in the presence of a catalyst produced by precipitating a difficultly reducible metal hydroxide gel, and while still wet depositing zinc oxide thereon and partially dehydrating the gel.

W. F. Huppke. U.S.P. 2,279,199, 7.4.42. Appl. 21.2.39. Method for the dehydrogenation of hydrocarbons which involves subjecting a hydrocarbon to a high temperature in the presence of a catalyst comprising an oxide from the class consisting of uranium and vanadium oxides. The oxide is distributed upon an oxide of the class consisting of aluminium, zirconium, and thorium hydrous oxide gels, and the catalyst contains a zinc oxide activator.

M. Pier. U.S.P. 2,280,258, 21.4.42. Appl. 1.3.39. Process for the destructive hydrogenation of hydrocarbon oils to produce gasoline and middle oil. The process includes the introduction of gaseous olefins into the reaction zone in an amount of at least 10% by weight of the oil treated, and at a point where the oil has already undergone considerable splitting. H. B. M.

Polymerization.

731. Shell Isomerization Process for Producing Isobutane. Anon. *Nat. Petrol. News*, 24.12.41, **33** (52), R403.—Normal butane in vapour phase is passed at relatively low temperature and pressure over aluminium chloride catalyst supported on an inert base. Anhydrous hydrogen chloride is added to the butane in controlled quantity for the purpose of improving the efficiency and life of the catalyst. The one-pass products are condensed by a refrigerant and freed from HCl in a stripping tower, the HCl being recycled. The theoretical yield of *iso*butane is about 68%, and the normal commercial yield 40–45%. The mixed *iso*butane and unconverted butane are passed via a NaOH wash to the alkylation unit, the butane, unaffected by alkylation, being returned to the isomerization unit. All materials are rigorously dehydrated to reduce corrosion, which is negligible except when contact with the air is unavoidable. Only at these points have special alloys to be used. Elsewhere carbon steels are suitable. H. G.

732. Patents on Polymerization and Alkylation. E. I. Du Pont de Nemours. E.P. 545,193, 14.5.42. Appl. 5.10.40. Polymerization of aliphatic open-chain conjugated diolefinic hydrocarbons, such as butadiene and its homologues, to form soluble viscous, oily polymers possessing drying properties.

Standard Oil Development Co. E.P. 545,441, 27.5.42. Appl. 14.5.40. Production of saturated, normally liquid hydrocarbons suitable for use as motor fuels by the catalytic alkylation of saturated paraffin hydrocarbons containing at least one tertiary carbon atom with a mono-olefin. The catalyst consists of a solution of boron fluoride in orthophosphoric acid.

C. M. Hull. U.S.P. 2,278,445, 7.4.42. Appl. 8.10.38. Production of lubricating oils by polymerizing olefin hydrocarbons contained in a hydrocarbon gas mixture. The mixture is subjected in liquid phase in a first polymerization stage to the action of an excess amount of boron fluoride catalyst. In this way the major portion of the olefin hydrocarbons is polymerized, and a substantial portion of the excess catalyst forms a complex compound with the hydrocarbons. Unreacted hydrocarbon gases are removed from the complex compound and polymerization products and the compound treated in a second stage with additional olefin gases in excess. In this way practically all the catalyst complex is decomposed and additional polymerization products are produced. The excess gases are introduced into the first polymerization stage, and the polymerization products are distilled to separate these from the desired lubricating-oil fraction.

D. H. Putney. U.S.P. 2,281,248, 28.4.42. Appl. 2.8.41. Method of alkylation in which *iso*paraffinic hydrocarbons are alkylated with olefinic hydrocarbons in the presence of a condensation catalyst. The improvement comprises selectively absorbing the olefinic hydrocarbons of the charge in the catalyst prior to alkylation and limiting the residence time period of contact of the catalyst and olefins in minutes to less than one tenth of the volumetric catalyst olefin hydrocarbon ratio. H. B. M.

Refining and Refinery Plant.

733. **A Note on Refining Light Oils by Silica Gel.** A. G. Arend. *Petrol. Times*, 18.4.42, **46** (1167) 184.—The highly non-reactive properties of silica-gel are among the material's most attractive features, and its use in substitution of sulphuric acid treatment offers advantages. Acid-washing may involve a through-put loss of as much as 35% valuable constituents often being lost. Its use on aromatic products is particularly appropriate, owing to the reactive nature of these bodies. Silica gel is now being produced as a by-product in sundry metallurgical processes, to the pecuniary advantage of both ore and oil refiner. H. G.

734. **Patents on Refining and Refinery Plant.** Standard Oil Development Co. E.P. 544,915, 4.5.42. Appl. 10.6.40. Improved method of effecting a separation of the products of a petroleum hydrocarbon conversion process into relatively clean, desirable products and relatively highly carbonaceous products. The total product is withdrawn from a cracking or reforming zone at a temperature of about 850° F., and a hydrocarbon boiling in the range 200–700° F. is added to it. The mixture is then conducted at a temperature between 600° and 800° F. to a separation zone maintained under the reaction pressure, where it separates into a clean layer and a tarry layer.

Standard Oil Development Co. E.P. 547,729, 10.6.42. Appl. 23.10.40. Process for the separation of ethyl chloride from a mixture comprising ethyl chloride and butane—*e.g.*, an azeotropic mixture of ethyl chloride and butane. The mixture is contacted with a solvent having a preferential selectivity for the ethyl chloride under conditions to form a raffinate phase and a solvent phase.

H. C. Paulsen. U.S.P. 2,278,665, 7.4.42. Appl. 14.9.39. Method of converting mercaptan compounds contained in petroleum oil into disulphide compounds. The oil is contacted in an initial stage with a sodium plumbite solution under conditions designed to convert the mercaptan compounds into soluble lead mercaptides. The spent sodium plumbite solution is separated from the oil, and the treated oil fraction is passed to a secondary stage, where it is contacted with hydrogen peroxide under conditions designed to convert the lead mercaptides to lead oxide and disulphide compounds. In this way a water layer is formed which is separated from the oil. The treated oil is then passed to a third stage, where it is contacted with the spent alkali-metal plumbite solution. In this way lead oxide is completely removed from the oil.

K. H. Engel. U.S.P. 2,279,778, 14.4.42. Appl. 15.5.40. Production of a hydrocarbon oil of high indene content from a hydrocarbon oil of relatively low indene content. The process includes distillation of the original oil in the presence of sufficient phenol to form an azeotrope with non-indene components.

K. H. Engel. U.S.P. 2,279,779, 14.4.42. Appl. 15.5.40. Production of hydrocarbon oil of high indene content from a hydrocarbon oil of relatively low indene content. The process includes distilling the original oil in the presence of a glycol compound capable of forming azeotropes with the non-indene oils contained in the hydrocarbon oil.

K. H. Engel. U.S.P. 2,279,780, 14.4.42. Appl. 15.5.40. Production of hydrocarbon oil of high indene content from a hydrocarbon oil of relatively low indene content. The process includes distillation of the hydrocarbon oil in the presence of an organic compound having a radical selected from the group consisting of the hydroxyl, the carboxyl, the amino, and the pyridinic nitrogen radicals, and capable of forming azeotropes with indene and with the non-indene oils contained in the original oil.

T. J. Brown. U.S.P. 2,279,937, 14.4.42. Appl. 8.5.40. Method of distilling crude petroleum oil which involves mixing *para*-cymene with the crude oil, and afterwards heating the mixture to a temperature sufficient to cause flocculent precipitation of the wax from the oil and the light ends to pass off.

A. R. Nevitt. U.S.P. 2,280,445, 21.4.42. Appl. 5.6.39. Method of treating hydrocarbon oils, which comprises subjecting a paraffin-base petroleum hydrocarbon and a chemically reactive aqueous solution of metallic chlorides and soluble metallic

sulphates to a high temperature at superatmospheric pressure in an enclosure, for a sufficient period of time to effect partial decomposition of the hydrocarbon. The mixture is then flashed under controlled pressure conditions, and the spent chemical solution is separated out. The treated hydrocarbon is finally fractionated and cooled.

F. G. Straka. U.S.P. 2,281,338, 28.4.42. Appl. 18.8.39. Conversion process which involves fractionally distilling hydrocarbon oil of relatively wide boiling range to separate therefrom a heavy gasoline fraction and a fraction suitable as catalytic cracking stock. The latter fraction is catalytically cracked, and the resultant products are fractionated to separate gasoline from higher-boiling hydrocarbons. At least a portion of these higher-boiling hydrocarbons is combined with the heavy gasoline fraction and the resultant mixture thermally cracked. H. B. M.

Analysis and Testing.

735. The Correlation of Filter Plant Yields with Laboratory Results. G. C. Jones. *Nat. Petrol. News*, 18.2.42, **37** (7), R57. On the basis of considerable laboratory work which has been done in conjunction with refinery filter plants, an example of which is presented, it is concluded that by means of the laboratory method previously described (see abstract No. 341) plant yields can be checked within 5%, provided plant control and burning are efficient. Greater deviation has been experienced during warm and humid weather than during colder weather. This has been shown to be due to the greater absorption of water by the clay under the more humid conditions, with a consequent decline of efficiency. H. G.

736. Examination of Emulsions. L. Ivanovszky. *Petroleum*, January 1942, **5** (1), 13. —A new design of separating funnel combines a decomposition vessel, fitted with reflux condenser, with a separation funnel and a graduated cylinder. The funnel is in effect the standard type cut along the stem into two parts. Suitable fittings enable it to be placed horizontally in a water-bath, where the widened section acts as the decomposition vessel. Placed vertically, the instrument acts as a measuring cylinder and separating funnel. R. A. E.

737. Reid Vapour Pressure of Alcohol Blends. S. J. W. Pleeth. *J. Inst. Petrol.* June 1942, **28** (222), 113–114.—Two precautions are stressed. The sample cannot be obtained by water displacement. Secondly, rinsing with water has been found to result in the separation of the alcohol blend into two phases. A modified procedure is described. A. H. N.

Chemistry and Physics.

738. Patent on Chemistry and Physics of Hydrocarbons. W. C. Astbury and F. H. Garner. U.S.P. 2,278,684, 7.4.42. Appl. 29.3.40. Production of an aqueous emulsion of the oil-in-water type containing an alkali metal salt, the anion of which contains a metal selected from the group consisting of aluminium, tin, boron, chromium, molybdenum, vanadium, and zinc, in conjunction with aliphatic amines having at least one aliphatic substituent of at least 11 carbon atoms. H. B. M.

Motor Fuels.

739. New Specifications Issued by British Petroleum Mission. Anon. *Nat. Petrol. News*, 24.12.41, **33** (52), R408–R410, R416.—Revised specifications for twenty-one products, including four new ones, have been issued by the British Petroleum Mission in Washington governing requirements of the British Government under Lease-Lend arrangements. The four additions concern finished alkylate for blending into 100-octane aviation gasoline, low-cold test distillate or residuum for lubes, Columbian lube distillate, sodium-naphtha-sulphonate (soluble cutting-oil base). The specifications are given in full, together with a list of the official test methods. The following specifications are unchanged: Pool Motor gasoline, White spirit, gas oil, diesel oil, marine diesel, marine fuel, W/D gas oil, special refinery gas oil, and Admiralty fuel oil. H. G.

740. Patents on Motor Fuels. Texaco Development Corp. E.P. 545,183, 14.5.42. Appl. 8.12.39. Method of manufacture of high anti-knock motor fuel by stabilising cracked naphtha to remove substantially all hydrocarbons of less than five carbon atoms in the molecule. In this way a stabilized cracked naphtha is produced of lower volatility than commercial gasoline, also a normally gaseous hydrocarbon fraction containing *iso*butane, normal butane, and olefins. This fraction is subjected to alkylation in the presence of an excess of *iso*butane and an alkylation catalyst. High anti-knock, normally liquid hydrocarbons within the gasoline boiling range are thus produced. Excess *iso*butane, normally liquid hydrocarbons, and normal butane are separated from the reaction products, and the excess *iso*butane is then recycled to the alkylation operation. Finally the normal butane is combined with the stabilized cracked naphtha to impart volatility thereto.

Standard Oil Development Co. E.P. 545,464, 28.5.42. Appl. 24.10.40. Production of a motor fuel for high-compression ignition engines, consisting of a gasoline hydrocarbon blended with an unsaturated ether represented by the general formula R-R-R', in which R is an aliphatic olefinic radical or a saturated hydrocarbon radical containing more than two carbon atoms.

G. B. Zimmerman. U.S.P. 2,279,547, 14.4.42. Appl. 9.6.39. Production of anti-knock motor fuel from crude petroleum by topping the crude to produce straight-run gasoline fractions and afterwards cracking portions of the crude heavier than gasoline to produce cracked gasoline. This is then combined with the straight-run gasoline fractions, and the resultant mixture is subject to aromatization in the presence of a dehydrocyclization catalyst. Finally the aromatized gasoline is recovered.

F. W. Leffer, U.S.P. 2,281,361, 28.4.42. Appl. 30.11.38. Production of anti-knock motor fuel from gasoline distillates of low anti-knock value. The distillate is separated into a light fraction and a heavier fraction, and the light fraction is cracked in a heating zone. From the resultant products there are separated a condensate containing heavy gasoline hydrocarbons and a lighter fraction containing normally gaseous olefines. The heavier distillate is re-formed, and at least part of the condensate is mixed with the heated products from the second heating zone. The resultant mixture is fractionated to separate a gasoline product from normally gaseous olefins. The latter are combined with the lighter fraction containing normally gaseous olefins, and the final mixture subjected to polymerization. H. B. M.

Gas, Diesel and Fuel Oils.

741. Patents on Gas, Diesel and Fuel Oils. Standard Oil Development Co. E.P. 545,125, 12.5.42. Appl. 8.10.40. Preparation of an improved Diesel fuel consisting of a hydrocarbon Diesel fuel oil blended with a minor proportion of a high-molecular-weight diacyl peroxide containing from sixteen to thirty carbon atoms per molecule, or with a minor proportion of a mixture of such peroxides.

G. H. Cloud. U.S.P. 2,280,217, 21.4.42. Appl. 30.11.38. Preparation of a compression ignition fuel of the Diesel type, and consisting of a hydrocarbon fuel having a flash point above 150° F. and a small amount of an alkyl nitrate having at least ten carbon atoms per molecule.

H. C. Paulsen. U.S.P. 2,280,716, 21.4.42. Appl. 28.10.39. Preparation of a compression ignition fuel consisting of a hydrocarbon Diesel fuel oil, 0·1–5% of nitrogen tetrasulphide, and an amount of 1-mercaptobenzothiazole effective to lessen the normal deterioration of the nitrogen tetrasulphide. H. B. M.

Lubricants and Lubrication.

742. Frictional Phenomena. Part IX. A. Gemant. *J. appl. Phys.*, May 1942, **13** (5), 290–299.—This part of the paper deals with the application of liquid viscosity to electrical insulating liquids, particularly in high-volatge cables. The subject is discussed under: (1) mechanical processes involving viscosity, particularly (*a*) im-

pregnation, (*b*) breathing, (*c*) oil migration with respect to high-voltage cables; (2) chemical processes involving viscosity, such as (*a*) Voltol process, (*b*) wax formation in cables, (*c*) polymerization of styrene; (3) electrical conductivity. With regard to the latter, the fundamental quantities, besides viscosity, that determine the conductivity are discussed, together with the various experimental methods the interpretation of which allows the quantities in question to be computed. A. H. N.

743. Improving the Efficiency of Lubricating Oils. A. H. Stuart. *Petroleum*, Dec. 1941, **4** (8), 179.—The functions of various types of addition agents for use with mineral lubricating oils are outlined and examples given of the agents used for each specific purpose. Among the substances considered are fatty acids, colloidal graphite, anti-oxidation and anti-sludge agents, anti-corrosion agents, and pour-point depressants. R. A. E.

744. The Development of Ball Bearing and Roller Bearing Greases. H. M. Fraser. *Nat. Petrol. News*, 21.1.42, **34** (3) R22.—The properties of greases are discussed under six headings—viz. (1) oxidation stability, (2) mechanical stability, (3) oil separation, (4) starting torque at low temperatures, (5) melting point, and (6) texture. The appropriate control tests are dealt with, and the effect of the variation of particular properties on general characteristics is discussed. H. G.

745. Lubricated Plug-Valves. P. Meredith. *Petroleum*, Dec. 1941, **4** (8), 180.—The plug-cock is the only type of valve in which machined surfaces are not exposed to the direct action of line fluid, and therefore possesses inherent advantages over other types of valve from the standpoint of resisting corrosion and erosion. The old unlubricated type suffered from the disadvantages of liability to stick and to seize. By application of pressure lubrication of correct design and the use of a suitable lubricant these disadvantages can be overcome and the valve sealed against entry of line fluid between machined surfaces. The lubricant should be inert in the service handled, capable of withstanding the service temperature, and possess the requisite viscosity to make it effective as a sealing medium. Pressure lubrication has made possible the use of plug-valves on services calling for test pressures up to 1500 lb. per sq. in. and the building of valves up to 30 in. bore. The uniform dispersion of lubricant over the contact surfaces without distortion of the valve-body by reason of excessive lubricant pressures is of great importance. Dissipation of lubricant into the line should also be avoided. Lubricating systems and desirable properties of lubricants are discussed. R. A. E.

746. Patents on Lubricants and Lubrication. Texaco Development Corp. E.P. 544,914, 4.5.42. Appl. 30.3.40. Preparation of a lubricating oil adapted for crankcase lubrication in internal-combustion engines, and consisting of a mineral lubricating oil, 0·1–2·0% by weight of a phosphatide compound and 0·1–2·0% by weight of a stannous soap selected from the group consisting of stannous naphthenate and mineral-oil-soluble stannous sulphonates.

Standard Oil Development Co. E.P. 545,355, 21.5.42 Appl. 12.11.40. Preparation of a lubricant consisting of an oil-base stock, one or more compounds for increasing the load-carrying capacity of the base-stock, such compounds containing chlorine with or without both sulphur and phosphorus, and a minor proportion of an amine having attached to the nitrogen at least one aliphatic or hydroxy aliphatic group containing an isocyclic ring.

Standard Oil Development Co. E.P. 545,519, 1.6.42. Appl. 18.4.40. Production of lubricants consisting of a hydrocarbon lubricating oil and from 0·1 to 5% of an organo-phosphorus compound consisting of a substituted phosphine or diphosphine, in which one or more of the hydrogens is replaced by a carbon atom of an organic group.

D. E. Birgen. U.S.P. 2,278,762, 7.4.42. Appl. 11.1.41. Preparation of a lubricant consisting of a mineral lubricating oil and less than 2% of an acylated derivative of an amino-heterocyclic sulphur compound containing the sulphur in the ring and the amino-group as a side-chain.

E. S. Hillman. U.S.P. 2,278,851, 7.4.42. Appl. 9.9.39. Preparation of an anti-wear lubricant consisting of a mineral lubricating oil and small amounts of a free aliphatic unsaturated ketone having at least ten carbon atoms, and an anti-wear compound which is substantially non-corrosive under lubricating conditions. The anti-wear compound contains as its active ingredient a semi-metallic element capable of forming with bearing metals alloys having melting points substantially lower than the said metals.

R. F. Bergstrom. U.S.P. 2,279,086, 7.4.42. Appl. 23.9.40. Preparation of a lubricant suitable for internal-combustion engines which contains dissolved therein 0·25–5% of a sulphonate salt and 1–10% of a sulphurized ester having at least ten carbon atoms combining a monohydric alcohol with a monocarboxylic acid.

M. A. Dietrich. U.S.P. 2,279,560, 14.4.42. Appl. 8.5.40. Preparation of a lubricant consisting of a major proportion of a viscous hydrocarbon oil and a small proportion of an organic hydroxamic acid compound selected from the group consisting of organic sulphonhydroxamic acids, the carboxylic esters and ethers of these acids, and carboxylic acid esters and ethers of organic hydroxamic acids.

M. A. Dietrich. U.S.P. 2,279,561, 14.4.42. Appl. 15.5.40. Stabilization of a viscous petroleum oil by incorporating therein a small proportion of a condensation product of 1 mole of an aliphatic polyamine in which two amino-groups are primary amino-groups directly attached to different aliphatic carbon atoms with from 3 to 10 moles of an aliphatic aldehyde of at least three carbon atoms having at least one hydrogen atom on the carbon adjacent to the –CHO group.

D. R. Merrill. U.S.P. 2,280,338, 21.4.42. Appl. 23.12.38. Preparation of a liquid mineral lubricating oil composition containing about three fourths of 1–2·5% of an oil-soluble carboxylic acid soap to overcome the formation of gummy and resinous materials tending to ring-sticking in heavy service internal combustion engines. The oil also contains a small proportion of a chlorinated aromatic compound containing chlorine in the aromatic ring and boiling above 600° F., in quantity sufficient to overcome the deposition of hard carbon behind piston rings. The oil is free from appreciable increase in viscosity over the original oil.

C. E. Wilson. U.S.P. 2,280,419, 21.4.42. Appl. 16.7.40. Preparation of a lubricant consisting of a mineral lubricating oil, a small proportion of an oil-soluble petroleum sulphonate, and a small proportion of the salt of a weak non-carboxylic organic acidic material having an ionization constant not exceeding about 5×10^{-4}.

R. Reuter. U.S.P. 2,280,450, 21.4.42. Appl. 20.2.40. Preparation of a lubricant consisting of a relatively large proportion of a refined hydrocarbon oil and in intimate admixture therewith a relatively small amount of an oil-soluble, water-insoluble reaction product of tricresyl phosphite and octyl phenoxy-ethanol to prevent deterioration by oxidation.

G. D. Byrkit, U.S.P. 2,280,474, 21.4.42. Appl. 18.7.38. Manufacture of a lubricating composition comprising a major proportion of an oil having lubricating characteristics and a minor proportion of a metal salt of an organic acid containing an ester group elsewhere in the molecule.

G. D. Byrkit. U.S.P. 2,280,475, 21.4.42. Appl. 10.7.40. Preparation of a lubricant comprising in combination a major proportion of an oil having lubricating characteristics and a minor proportion of a metal salt of a hydroxy-acid the hydroxyl group of which is esterified.

E. W. Fuller. U.S.P. 2,281,520, 28.4.42. Appl. 18.2.39. Preparation of a lubricant consisting of a viscous mineral oil fraction and a small proportion of a paranitroso dialkyl aniline to inhibit deleterious effects of oxidation.

E. W. Fuller. U.S.P. 2,281,521, 28.4.42. Appl. 8.10.40. Preparation of a lubricant consisting of a viscous hydrocarbon oil and a small proportion of a reaction product obtainable by reacting substantially equal proportions of a mercaptan, an aromatic amine and formaldehyde. H. B. M.

Asphalt and Bitumen.

747. Wartime Requirements for Asphalt. G. Abson. *Nat. Petrol. News*, 18.2.42, **34** (7) R60.—It is assumed that with at least a partial prohibition of the use of steel for the reinforcing of concrete for road foundations the war will increase the demand for asphalt. The demands for new military roads and for aerodrome run-ways and tracks bring their own extra demands. It is pointed out that the flexible nature of a bituminous carpet has a special appeal when the demand for speed may preclude the proper preparations of the sub-grade. Typical specifications for bituminous material used in air-field construction are given under the following headings—Hot mix, cut back asphalt, seal coat, bituminous emulsion, and road oil. H. G.

748. Patents on Asphalt and Bitumen. Standard Oil Development Co. E.P. 545,287, 19.5.42. Appl. 4.9.40. Method of preparing a paving composition by mixing a mineral aggregate in its natural state, or after drenching with water, with a bituminous binding agent containing oleylamine. The process is particularly useful in connexion with aggregates which are acidic and/or highly siliceous, and also when bituminous roads are laid in damp or wet places.

J. C. Roediger. U.S.P. 2,278,671, 7.4.42. Appl. 10.10.39. Method of producing a bituminous bonding agent by blending a high-softening-point cracking coil-tar with a relatively low viscosity cracking coil-tar produced from gas-oil and low-viscosity tars produced from the cracking of crude petroleum. H. B. M.

Special Products.

749. The Manufacture of Synthetic Rubber. G. B. Murphy. *Nat. Petrol. News*, **34** (7) 18.2.42, R51–R56.—The article deals in a very superficial manner with the manufacture of synthetic rubber from butadiene and styrene. The aim is to produce 400,000 tons p.a., and it is estimated that production will reach 90,000 tons p.a. by the end of 1942. The essential features of the process comprise the co-polymerization of butadiene and styrene in the presence of a peroxide catalyst to form an emulsion with water. The emulsion is coagulated with acid, water expressed, and the coagulum masticated by the method of normal rubber manufacturing technique. The present cost of synthetic rubber is much greater than that of the natural product, but larger-scale production is expected to reduce the cost very considerably. H. G.

750. Patents on Special Products. Standard Oil Development Co. E.P. 545,293, 22.5.42. Appl. 22.5.40. Process for the catalytic isomerization of normal to *iso*-heptane wherein the normal heptane is contacted with aluminium chloride or aluminium bromide. The conversion reaction is carried out in the liquid phase at pressures not above atmospheric.

Standard Oil Development Co. E.P. 545,412, 26.5.42. Appl. 1.7.40. Process involving contacting at least one normal paraffin containing at least four carbon atoms per molecule with an isomerization catalyst under isomerization conditions in a step-wire process. The reaction is carried out in at least two stages, and a temperature gradient maintained between the stages. H. B. M.

Engines.

751. Pre-exhaust Gas-pressure Measurements for Indicating Diesel Engine Performance. B. H. Jennings and T. E. Jackson. *Gas Oil Power*, Dec. 1941, **36** (435), 269.—The use of the release pressure for indicating load conditions in the cylinders of I.C. engines has been proposed, and an instrument devised that operated effectively on this principle.

In this paper the principle is explained and developed and the experimental programme and data corroborating the idea are presented.

The problem of experimentally measuring the pre-exhaust pressure is a relatively

simple matter, and one arrangement is illustrated in a diagram relating to a two-stroke cycle Diesel engine. A series of tests were run, using three units: (*a*) a four-cylinder single-acting $8\frac{1}{2} \times 12$ in. two-stroke-cycle Diesel; (*b*) a two-cylinder $12\frac{1}{2} \times 13$ in. single-acting crosshead type, two-stroke-cycle engine, and (*c*) a standard C.F.R. Diesel fuel-testing unit. All the tests indicated that there was a definite value of release pressure related to the brake and indicated M.E.P. being developed by an engine at a given time. With the multi-cylinder engines, using the release-pressure readings as indexes for balancing and adjusting the load between the various cylinders, was a simple yet effective method of control.

Although release pressure showed a definite relationship to B.M.E.P. for each particular engine, there was no relationship apparent between the three different engines. D. L. S.

Coal and Shale.

752. Shale Oil Production in Russia. Anon. *Petrol. Times*, 24.1.42, **46** (1161), 49.—The Gdov district is said to contain 5×10^9 metric tons of oil shale of oil content 18%. This district is at present in enemy hands. Two workings capable of producing 5×10^5 tons p.a. are in operation, but in the 1937–39 period they produced only half this quantity. The same district has the only low-temperature shale-oil plant. The petrol is said to contain 6% S, and has to be hydrogenated. H. G.

753. A Technical Study of Transvaal Torbanite. S. L. Neppe. *J. Inst. Pet.*, June 1942, **28** (222), 194–108.—As an addendum to the author's previous paper on this subject (*J. Inst. Pet.*, February 1941, **27** (208), 31) further experimental results are presented dealing with pressure extraction of the torbanite. A. H. N.

754. Peat as Fuel. Anon. *Petroleum*, January 1942, 5 (1), 11.—The possibility of domestic utilization of peat in this country as a fuel is under consideration. A brief review of the formation of peat bogs is given and the peat resources of various European countries are surveyed. In Denmark, Sweden, and Eire completely mechanized establishments for harvesting the peat and the manufacture of briquettes have been constructed. All operate on the Peco process. Ditches 4 ft. deep, about 2 ft. wide, and up to a mile in length are cut in the surface 50 ft. apart. A track-laying tractor equipped with a cutter 8 ft. in diameter, sunk about half its diameter into the surface, is used for this purpose. The ditches drain the bog moisture content from 92% to 88% and allow the surface to take heavier weights. The surface is then milled off to a depth of $\frac{1}{2}$ in. by a long drum of $2\frac{1}{2}$-ft. diameter carrying cutters revolving at about 800 r.p.m. The peat is thrown up by these cutters as a powder on the surface, where it is allowed to remain for some hours, depending on weather conditions, to dry. The powder (moisture content 50%) is gathered into ridges and then placed on a belt conveyer and loaded into trucks, which deliver it to the factory. The powder is screened to remove twigs and fibrous materials which are used for steam-raising. The screened powder is blown through hot-water or steam-heated pipes, variations in moisture content of feed being compensated by blending back with partly processed peat. The powder passes through five stages of drying, and then goes to the briquetting press. A pressure of about 5 tons per sq. in. is applied, and the press is water-cooled to maintain a temperature low enough to prevent damaging the briquette. As the harvesting season is not longer than 6 months in the year, the factory is designed to operate at a lower rate than the harvesting section. Stacking and blending of the surplus peat obtained during the harvesting require special care to avoid overheating and to obtain best results during subsequent treatment. The final moisture content of the briquette is 10–12%. The briquetted peat has a calorific value of 8000–9000 B.T.U. per cu. ft., but its radiation value in an open fire is given as 18% compared with coal at 10–12%. Economics of the process and purposes to which peat is applied abroad are discussed. R. A. E.

755. Producer Gas Developments in Continental Europe. Anon. *Petrol. Times*, **56** (1161), 24.1.42.—Germany has the largest number of generator gas operated vehicles, but progress in Sweden has been rapid owing to the favourable fuel supply. In the middle of 1941 60,000 such vehicles were registered in Sweden. The first producer-

gas ship is reported, and Denmark is building a 3000-ton vessel to operate on gas from coal and coke. In Germany and occupied countries 180,000 lorries were running on generator gas last year. Dwindling supplies of wood have promoted the use of anthracite, peat, lignite, etc. The fuel supply, in general, has controlled the rate of development, which has been slow in Belgium, Holland, Finland, and Hungary. In France progress has been considerable, but again supplies of wood and sheet iron for the construction of kilns cause difficulties. H. G.

756. The Future of Road Transport Fuels. J. Devon. *Petroleum*, January 1942, **5** (1), 3.—Future possibilities of some alternative fuels and practicable applications in war-time to existing engines and vehicles are discussed. Conversion to electric battery operation of cars and vans having a daily mileage of 30–50 miles, replacing the engine and gear-box by an electric motor and controller, is feasible, and may result in economies. Charging of batteries could take place at night, when demand for current is low. The main application of producer-gas plants has been to transport vehicles and lorries. The power output obtainable from a given engine is appreciably lower than when gasoline fuel is used, and falls off during the run as the volatiles are driven off from the fuel in the generator. Plants designed to use charcoal as fuel were found unsatisfactory when running on anthracite or coke fuel; additional filtration of the gas was essential. Owners of large fleets operating gas producers are making revisions to plants as now manufactured in the light of their operating experience, so that improvements on present design may be expected. Correct maintenance of the generating and filtration plants is essential in order to avoid the possibility of damage to the engine. Unless used for light duty on flat roads, increase in compression ratio of the engine is necessary, and change in axle ratio may also be required.

Power output on town gas from a given engine is about 75–90% of that obtainable on gasoline, but the use of steel cylinders to store the gas under pressure is not practicable in war-time. A roof gas-bag contains sufficient gas for only a 15-mile run. Increase of compression ratio of the engine to give improved performance on town gas will adversely affect running on gasoline. Special sparking-plugs are sometimes required to avoid overheating of engines running on town gas.

Steam engines appear to offer possibilities if advantage is taken of developments in steam-driven electricity-generating stations.

The use of creosote, acetylene, or alcohol is impracticable in war-time, and the future application of these fuels is considered to be limited for various reasons. The use of methane appears to have promising possibilities in the future. Methane can be used in compressed or liquefied form and applied to existing engines with little or no modification, or, alternatively, greater power output could be obtained by increase in compression ratio of the engine. Certain sewage-disposal works provide a ready source of methane supply. A new proposal from America, where the system is already in operation, is to extract methane from coal deposits by horizontal drilling, insertion of pipe, and application of vacuum. Vertical pipes convey the gas to the surface, where it can be liquefied. On the average about 1000 cu. ft. of methane is contained in a ton of coal, so that a considerable output might be expected.

R. A. E.

757. Conversion of Petroleum Oil-Burning Plants to Coal Tar Fuels. Anon. *Petroleum*, December, 1941, **4** (8), 169.—In order to conserve tanker space the Petroleum Department, in conjunction with the Petroleum Board, has been pressing suitable consumers to utilize a mixture of 50% creosote, 50% pitch as fuel in substitution for petroleum fuel. Considerable stocks of pitch are available for such use owing to cessation of exports to the Continent and the need for maintaining tar distillation at the highest possible level. After using all available creosote there will be further supplies of pitch available for use tel quel. One of the biggest consumers of liquid fuel in the country has used the mixture for steam raising for a considerable period, and reports satisfactory results from the technical aspect and an economic advantage at present-day fuel prices. Properties of creosote, pitch, and the mixture are given and compared with those of petroleum oils and the method of production of the creosote/pitch blend described. Medium soft pitch and the mixture for use as liquid fuels are loaded at temperatures of 200° C. and about 120° C., respectively, into road and rail tank-waggons and in insulated tanks remain pumpable for 24 hr. or longer.

In storage tanks the common practice is to maintain a temperature between the flowable and burning temperatures—*i.e.*, temperatures at which the fuels have viscosities R.I. of 3000 secs. and 100 secs., respectively. For medium pitch these temperatures are 260° F. and 392° F., and for the mixture 80° F. and 200° F. Internal or external heating may be applied, and the storage tank and all pipe-work should be free from joints made with rubber. Duplicate pumps are recommended, and fuel lines throughout their entire length should be lagged with inclusion of either a steam tracer line or electric heating cable. The ideal arrangement is to circulate the fuels by pump through a ring-main past the burners and back to the storage tank, the pump capacity being at least double the burner output. This ensures correct oil temperature at burners and assists in maintaining uniform tank temperatures. Alternatively, a steam-jacketed gravity feed-pipe from tank to burner may be used. Both systems are illustrated. Steam atomizing burners are generally used, and a recommended type is described. With creosote–pitch mixture pressure jet and certain types of low-pressure air burners may also be used. It is important that the burners should not have small orifices, and burner capacities usually range from 7 to 80 gals. per hr.

The use of valves, filters, etc., made of iron or steel is recommended, as some tar fuels exert a slightly corrosive action on brass and similar non-ferrous metals. To avoid precipitation and attendant difficulties, admixture with petroleum fuels should be avoided, and all traces of such fuels should be removed from the system when changing over to tar oils. Special precautions required to avoid solidification troubles when using grade B creosote (high pour point) and sedimentation troubles with creosote-pitch mixtures are outlined. For controlling supply of pitch or creosote-pitch to burners, ordinary screw-down valves are liable to become choked with deposit around the seating, and the use of a valve in which flow is controlled through an orifice is recommended.

Further recommendations are made in connection with the utilization of medium soft pitch in the liquid state and of pulverized hard pitch. R. A. E.

Economics and Statistics.

758. Biennial Report of Petroleum and Natural-Gas Division. Fiscal Years 1940 and 1941. R. A. Cattell, G. B. Shea and Others. U.S. Bureau of Mines. Report of Investigations No. 3616. Feb. 1942.—This report summarizes progress made during the years 1940 and 1941 by the Petroleum and Natural Gas Division of the United States Bureau of Mines towards their objectives of increased conservation and better utilization of petroleum, natural gas, and related resources through a co-ordinated programme of research. Owing to the present emergency, many of the Bureau's long-time research activities have been curtailed and attention has necessarily been focussed as far as practicable on problems associated with the needs of national defence.

The report is divided into seven main sections, comprising oil and gas development and production research; petroleum chemistry and refining; pipe-line transportation; chemical and engineering problems; helium operations; work for other Government departments; and visual-education activities. Discussions of problems listed under these headings are based upon statements submitted from the five field headquarters of the division.

Production research during the years under review centred around methods for obtaining and interpreting data relating to subsurface pressures and temperatures and the properties of reservoir oil as a means of analyzing reservoir performance; collection and analyses of cores; relation between decline in reservoir pressure and cumulative production of oil; factors influencing the productivity of wells; function of water in obtaining maximum oil recovery; and the effect of well-spacing on ultimate recovery.

Of particular interest in the chemistry and refining section is the development of a satisfactory method for separating asphalt into its components. The method involves: (1) precipitating the asphaltenes with hexane and separating them from the hexane-soluble material by centrifuging; (2) distilling the hexane from the hexane-soluble material, dispersing the residue on asbestos fibre, and extracting with acetone to

obtain an acetone-soluble fraction (oils plus waxes); (3) extraction of the residue from (2) with hexane to obtain a hexane-soluble fraction (resins); (4) extraction of the residues from (1) and (3) with benzene to give the benzene-soluble fraction (light asphaltenes); and (5) extraction of the residue from (4) to give the pyridine-soluble fraction (heavy asphaltenes).

Incorporated in the report is a bibliography of publications issued by the Petroleum and Natural-Gas Division during the years 1940 and 1941, together with a list of reports prepared by members of the Division outside the Bureau of Mines. H. B. M.

739. Agricultural Petroleum Fuel Consumption. K. N. Gess. *Petrol. Times*, 18.4.42, **46** (1167), 190.—Where the three main tractor fuels, gasoline, kerosine, and Diesel oil, can compete on an equal footing with regard to taxes, gasoline is the more popular fuel, but Diesel engines are rapidly gaining ground. In England the petrol taxes make the use of petrol-engined tractors prohibitive, and kerosine is the principal fuel. Crank-case oil dilution remains a big disadvantage attendant upon the use of kerosine. In U.S.A. and Canada, where taxes are refunded, in whole or in part, on gasoline used for agricultural purposes, distillate fuels represent only a small proportion of the total. It is concluded that there is a strong case for preferential treatment for agricultural tractor fuel in England, but that the greater fuel economy and improved performance of the Diesel engine warrant greater attention being paid to that form of traction. H. G.

BOOK REVIEW.

Source Beds of Petroleum. By P. D. Trask and H. W. Patnode. Pp. 566, 151 tables and 72 figures. American Association of Petroleum Geologists, Tulsa, Oklahoma, 1942. Price $4.50.

Although opinions have been expressed from time to time regarding the characteristics of petroleum source beds, no criteria appear to be known yet which can be applied definitely to demonstrate that a given bed has been the seat of oil formation. The discovery and application of such criteria are not merely of academic interest, even though large amounts of oil have been and are being found without this knowledge, for the finding of new oil fields is becoming increasingly difficult, and demands the use of all possible information about the conditions necessary to form an oil accumulation. The search for certain types of structure, a procedure which has tended to dominate the scene in the past, takes cognisance only of the fact that a commercial oil accumulation must have a suitable trapping feature: but favourable structure alone will not guarantee the presence of an oil accumulation unless there is also an oil source rock from which oil has been able to reach the trap.

In 1926 the American Petroleum Institute initiated a project for the study of petroleum source beds, and for a period of five years an investigation was made of the conditions of accumulation of organic matter in deposits of a type similar to those which are believed to have generated oil in the past. The results of this work were summarized in Trask's "Origin and Environment of Source Beds of Petroleum." A study of ancient sediments from the point of view of oil formation was begun in 1931, in conjunction with the Geological Survey of the U.S.A. "Source Beds of Petroleum" sets out the results of the ten years' work on ancient sediments.

The principal object of the investigation was to discover diagnostic criteria for recognizing oil source beds, but, as the authors admit, there is no certainty as to what is a source bed, and also it is difficult to be sure that beds which have acted as sources of petroleum will retain features distinguishing them from beds which have not performed such a function. Hence, the entire study has been based on the assumption "that sediments stratigraphically near known oil zones, in general, are better source beds than those far from oil zones. . . . The method of approach to the problem has been to determine several properties of individual samples of sediments from many oil fields in most of the oil-producing regions of the United States in order to ascertain whether or not any of these properties were related to the distance of the sediments from known oil zones. If consistent differences for individual properties were found for groups of sediments in several regions, the conclusion would be reached that such properties were related to the generation of oil."

Some 35,000 samples have been examined, 32,000 being well samples and the rest outcrop samples. 14,000 samples were from California, 6000 from the Rocky Mountain area, 6000 from the Mid-Continent, 3500 from East Texas, 3000 from the Appalachian area, 2000 from the Gulf Coast, and 500 from West Texas. The subsurface samples came from 434 wells distributed among 150 fields. 87 of the wells were at Santa Fe Springs, 49 at East Texas, and 22 at Burbank, with many of the remaining fields represented by only one well. The number of samples from a single well ranged from 2 to over 200. 36 of the fields were in Texas, 35 in California, 23 in Wyoming, and the rest in Colorado, Oklahoma, Pennsylvania, Kansas, West Virginia, Louisiana, Kentucky, New York, Ohio, Montana, Nebraska, New Mexico, and Mexico.

Cores, cable-tool, and rotary samples were employed, with their inherent differences as regards depth indications, degrees of mixing, and predominant lithological types. Generally the analyses were made on samples from individual horizons, but composite samples were used for certain purposes. At first samples were taken at 3–10 ft. intervals from several wells in a few selected areas, in order to find the general tenor of the organic matter and its vertical and lateral variations. Subsequently it was decided that a reliable determination of the general organic content and other constituents of the sediments could be obtained nearly as satisfactorily

if samples were taken at greater intervals, and so in later work samples were taken at 20–50 ft. intervals.

Some or all of eight properties were examined in the samples: (1) organic carbon content; (2) reduction number, which is a measure of the quantity of chromic acid that the sediments can reduce under given conditions; (3) nitrogen content; (4) assay number, which is a rough measure of the volatility of the organic constituents; (5) texture; (6) the content of bituminous substances; (7) colour; and (8) the calcium carbonate content. The methods of making the above determinations are described in detail, together with the limitations of the methods and the results generally, as well as on a regional basis. The significance of the various statistical indications is discussed, for this is the basis of the final conclusions.

From the basic determinations other quantities have been derived and studied, such as the relative volatility—the ratio of the volatility to the reduction number; the ratio of carbon to nitrogen; the nitrogen-reduction ratio—the ratio of the nitrogen content to the reduction number; and the oxidation factor—the ratio of the carbon content to the reduction number.

In the regional studies the areal and vertical variations of the properties are given, and also the relationship of the properties to the occurrence of petroleum on a stratigraphical and on a distance basis. In the first classification each sedimentary unit was put into one of five classes: (1) productive—units in which most of the samples were within 200 ft. of producing zones; (2) probably productive—most of the samples within 200 ft. of zones which produce oil in nearby areas, but not in the area of the sample; (3) questionable—units 200–500 ft. from producing or probably producing zones, or which contain small shows of oil; (4) barren—most of the samples over 500 ft. from the producing zone; (5) gas—most of the samples within 200 ft. of producing gas horizons or strong gas-shows.

The preceding classification involves certain assumptions, even if transformational migration alone is considered. The local stratigraphy may provide an indication of the chances that it is valid. If 500 ft. of sediments without any interbedded horizon which could act as a reservoir rock occur adjacent to the producing horizon, it is by no means certain that oil is more likely to have been formed in the nearer 200 ft. than in the more distant beds. Furthermore, it would have been preferable to avoid the use of "productive" in the names of the classes, especially when in the succeeding distance classification the term and its variants are used for the oil-producing horizons.

The nitrogen-reduction ratio was also examined on a basis in which the samples were grouped into ten classes: (1) within the confines of the producing zones; (2) 1–50 ft. above an oil zone; (3) 51–200 ft. above an oil zone; (4) 201–500 ft. above an oil zone; (5) over 500 ft. above an oil zone; (6) 1–50 ft. below an oil zone; (7) 51–200 ft. below an oil zone; (8) 201–500 ft. below an oil zone; (9) over 500 ft. below an oil zone; (10) wells in barren territory. The producing zones were divided into five classes: (1) productive—actually produce oil; (2) probably productive—barren in well sampled, but productive within 50–100 ml.; (3) shows—well has shows, but is not commercially productive; (4) gas—well yields gas; (5) a composite of classes (1), (2), (3), and (4).

The authors' final summary shows that according to the statistical methods employed, only the nitrogen-reduction ratio shows any definite relationship with oil, but even that is not absolute. Studies based on the distance of the samples from oil zones show that the ratio is lower near oil zones than far from them, but the significance of a given nitrogen-reduction ratio depends on the area. Consequently, a considerable amount of work must be done before the ratio can be applied. The ratio appears to be affected by metamorphism, nearness to the source of detritus, and texture. It cannot be used to locate fields, being essentially the same whether on or off favourable oil structure, and it seems more suitable for regional interpretation in wildcat territory. The ratio is of significance only if applied to well samples, and so it is not applicable until a test has been drilled, and that will have had to be located by means of other criteria. If the test is a failure, but the values of the ratio are suggestive, more wells will be needed before the true significance of the values can be decided.

The general range of the values of the nitrogen-reduction ratio seems to be 3 to 8, below 5 being a good index, 6 encouraging, 7 not very hopeful, and over 8 unfavourable, with poor prospects within 10–50 ml. in that bed, but without condemning the beds above or below.

The reduction number and the nitrogen content have been used to estimate the organic content of the beds by multiplying these quantities by factors which depend to some extent on the area in question. Therefore, the variation in the nitrogen-reduction ratio is a function of the conditions which lead to inconstancy in the multiplying factors. Some discussion on this point would have been of interest.

The volatility (assay number) and carbon–nitrogen ratio tended to be higher in productive than in barren sediments (Athy's and Patnode's terms), but the relationships were not constant, and so are of little value for prospecting. The organic content and colour were not found to be related to oil occurrence, and so it is concluded that they are not valid criteria for recognizing source beds. The organic content, carbon content, reduction number, nitrogen content, and relative volatility tended to be slightly higher in sediments near oil, while the oxidation factor tended to be very slightly lower, but there were many exceptions to these statements. The colour varied directly with the organic content, but the relationship depended on the area and the coarseness. The estimated organic content ranged 0·2–10%, the bulk of the samples showing 0·4–5%. The Californian sediments were richest in organic matter, and the Appalachian sediments the poorest. The variation of the organic matter with distance seemed to depend on the activity of diastrophism.

In view of the somewhat restricted possibilities in connection with the obtaining of samples, it is extremely doubtful whether the method of attack and of interpretation of the observations adopted is capable of yielding a solution to the problem. When an oil company drills wells, the wells are in certain very limited areas which are believed to be structurally favourable for oil accumulation, and apart from those drilled purely for structural data or for special purposes in connection with production methods, the wells are drilled with the object of obtaining oil. However, many recognize that if the geology is suitable, the oil present in the trapping part of the reservoir rock has not necessarily come from the immediate vicinity of the existing accumulation. In certain cases the geology may point to oil formation nearby, either above or below the actual accumulation, but in other cases there is the possibility that the oil has migrated laterally through the reservoir rock to the point of accumulation, and hence the effective area of source bed may be found above or below the reservoir rock some distance laterally from the site of the accumulation. Samples obtained from wells as normally located will be from the beds above and below the oil accumulation. The preponderance of these rather specialized samples, and their consideration statistically without due regard to the geology of the individual fields can, therefore, hardly be expected to lead to a satisfactory result.

Admittedly, the position with regard to samples is somewhat difficult. The researchers have to accept the samples which are available, since there are no funds for the drilling of considerable numbers of wells off structure at points which are unlikely to yield oil, but where valuable data on source beds might be obtained in some instances. Fields which appear extremely favourable for study because a complete picture of the geology is known, may be already drilled up and may have no suitable samples available. In other fields beds which might provide interesting data on source beds may not be penetrated because they lie below the oil horizon sought.

In their final paragraph the authors note that in "future investigations . . . special attention could advantageously be given to sediments which, because of their stratigraphic relations to known oil zones, almost certainly are source beds," although they make no mention of re-interpreting the large amount of data already obtained, in accordance with this recommendation. Provided that certain types of fields are among those sampled, re-examination of the data in conjunction with the detailed geological possibilities regarding migration and accumulation might prove extremely valuable.

No indication is given of the type of oil concerned in the various zones studied, and having regard to the recent claims of the ability of geochemical well-logging to detect oil accumulations laterally or ahead of the drill, it would have been of considerable interest to have any possible relationships of these observations to those described in the present volume discussed fully.

The volume shows clearly the enormous effort which has been expended on the project of finding determinative criteria for source beds of petroleum, but the final result is disappointing, and undoubtedly the authors feel disappointed too.

There is, however, the distinct impression that had the data been examined in conjunction with the geology of the fields, the conclusions might have been more valuable. As the basic analytical data are presented for each sample in a 113-page table, readers with a flair for statistics, detailed information on the geology and other features of the fields available, and ample time to give to the study, may be able to obtain more definite information concerning the measurable characteristics of source rocks than has been deduced in "Source Beds of Petroleum."

G. D. Hobson.

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Geology and Development.

760.* Drilling in United States Levelling Off at Reduced Rate. Anon. *Oil Wkly*, 11.5.42, **105** (10), 33.—The daily average rate of well completions in April was only slightly below the March rate, and nearly as many wells were drilling or rigging on 1st May as on 1st April. 1366 wells were completed in the four weeks ended 25th April, 1942, a daily average of 48·8, compared with 50·2 for March.

North Louisiana, Mississippi, New Mexico, West Texas, the Texas Panhandle, New York, Pennsylvania, and West Virginia have had more completions during the first four months of 1942 than during the corresponding period of 1941. 1999 wells were drilling on 1st May, 1942.

Data are tabulated by States and districts concerning the drilling activity in April 1941, March and April 1942, the cumulative completions during the first four months of 1942, and the activity on 1st May, 1941, and 1st April and 1st May, 1942.

G. D. H.

761.* Florida Leasing Activities Showing Increase. J. G. Heyck. *Oil Wkly*, 18.5.42, **105** (11), 41.—Much of the acreage under lease in Florida was leased late in 1939 and early in 1940. At present 3,605,000 acres are under lease, and they lie in five general areas: (1) Panhandle or West Florida (948,500 acres); (2) west flank of Ocala uplift (780,100 acres); (3) east flank of Ocala uplift (180,000 acres); (4) south-south-west flank of Ocala uplift (666,400 acres); (5) Everglades basin (1,030,000 acres).

In October 1941 marine leases were granted along the west and south coasts of Florida, and some 12,000,000 acres have been taken up on eighteen-month geophysical options. G. D. H.

762.* Typical Oil-field Structures ; Complexly Faulted Dome, Eola Field, Avoyelles Parish, Louisiana. Anon. *Oil Gas J.*, 21.5.42, **41** (2), 50.—The Eola field is along a trend associated with wedging sands, but it lies some distance from the old shoreline. The beds thicken towards the Gulf, and the coastwards dip is broken by salt domes and by faulted domes not definitely known to be associated with salt, which is generally considered to be Jurassic in age. The faulted domes may be due to compaction of soft formations around salt cores, or to adjustments in a subsiding wedge without being localized by salt or other resistant plugs.

Eola is a roughly oval dome on a broad, gentle regional nose on a seaward-dipping monocline. Most of the faulting cannot be traced above the Vicksburg, due to rapid facies changes rendering correlation difficult. The throw of the faults decreases upwards. The northerly closure dies out in the Cockfield.

The Cockfield and Sparta sands carry oil, but the main production is from the Wilcox. The different fault-block segments behave differently and have different bottom-hole pressures, although the water-level is the same.

The Cockfield is predominantly sandy and of near-shore or lagunal origin, with much carbonaceous matter which may be the source of the oil. The Wilcox is a black, silty, lignitic shale of shallow marine or lagunal origin.

The Wilcox production is not limited to the upper part of the formation, and as the Wilcox locally is several thousand feet thick, the possibility of picking up local shoreline trends is very great. The same is true of the Sparta, Cockfield, and still higher horizons.

Surface and subsurface geology are of little value in locating these deep-seated, complexly faulted domes. The reflection seismograph with the guidance of regional geology is responsible for most of the discoveries made so far. G. D. H.

763.* Results in South Caesar will Influence Carrizo-Wilcox Play. F. L. Singleton, *Oil Gas J.*, 21.5.42, **41** (2), 70.—The first commercial Carrizo production of Southwest Texas has recently been found just south of the old Caesar field. Three wells have revealed the existence of an important reserve, and a second 50-ft. sand has been found. Production is spread over a mile in a north-east–south-west direction on an elongated structure parallel to the Caesar field fault. The discovery well was completed at 6552–6557 ft. for 127 brl./day of 42-gravity oil on ¼-in. choke.

The second sand, showing salt water and a little oil in the discovery well, is 105 ft. deeper. It was logged as carrying gas-distillate in a second well.

The discovery well seems to be near the apex of the structure. Dry wells have been drilled which appear to limit the field to the south-east.

The area was leased on the basis of subsurface work, checked by geophysics.

The discovery has led to special attention being paid to other old Pettus sand-fields, many of which are practically depleted, but which can be regarded as favourable prospects in the light of recent developments. Deeper drilling is already under way at Tuleta and West Tuleta. G. D. H.

764.* April Completions Show Small Increase ; Fewer Drilling Wells. Anon. *Oil Gas J.*, 21.5.42, **41** (2), 11.—135 more wells were completed in April than in March, but the increase is partly due to working on a weekly basis and making April a five-week month. 20% of the completions were in the Appalachian district, which had 40% of the gas-wells. Ohio and Michigan showed considerable increases in activity, with Illinois and Indiana slightly ahead of March. Illinois completions were only 22% of the number for September 1941, and Oklahoma and Kansas had only 50% and 60% respectively of the activity at the corresponding time.

The numbers of completions in April and types are tabulated by States and districts, with the footage, and the numbers of wells in certain depth ranges. G. D. H.

765.* Location made in South Dakota for Test to Pre-Cambrian. Anon. *Oil Gas J.*, 21.5.42, **41** (2), 89.—Nearly 5,000,000 acres are reported to be under oil and gas lease

in South Dakota. The first deep test in Hughes County is to be drilled to the pre-Cambrian, which is estimated to be not more than 4500 ft. deep. It is on a 30,000-acre lease on a magnetic high. A test on the other side of the Missouri had oil showings in the younger formations. Tests drilled to the north and east found strong artesian flows in the Dakota and Sundance series. One found much gas in the Dakota. Little information has become available on three oil tests undertaken in South Dakota last year. G. D. H.

766.* Illinois Production Trend may be Reversed. H. F. Simons. *Oil Gas J.*, 18.6.42, **41** (6), 16.—The Illinois daily production of oil in May was 281,000 brl., compared with 287,000 brl. in April, but it is felt that the downward trend may end after May, as has happened in previous years. The downward trend may be stopped by new discoveries or extensions, by multi-zone production technique, or by a well-planned deepening campaign.

During May there was evidence of an increase in wildcatting. In numerous cases there are possibilities of two-zone production, but not many pools seem favourable for deepening.

Secondary recovery programmes are becoming commoner in Illinois. Repressuring and water-flooding are being employed.

Tables show the new field discoveries and extensions in Illinois up to 9th June, 1942, with the location, depth, producing formation, initial production, and number of wells; the number of permits for wildcats and pool wells issued each month since October 1941; and the completions by pools and formations so far this year.

G. D. H.

767.* Kansas Wildcat Campaign Keeps Near Proven Areas. Anon. *Oil Gas J.*, 18.6.42, **41** (6), 66.—Fifteen new producing areas and new oil horizons have been discovered in Kansas during the first half of 1942. Only one discovery was over 3 ml. from a developed area. On the north-western extension of the Central Kansas Uplift no discoveries have been made north of the Ray pool. Wildcatting declined 50% in the first half of 1942 and the percentage of dry holes was doubled.

A gas discovery was made in Barber County, where two new oil-zones were found in old pools. A new Burbank sand-pool was found in Cowley County and a Mississippian pool in Marion County. The finds ranged from the Pennsylvanian to the Cambrian in age.

The Barber County gas discovery was in the Viola, but the well also showed oil saturation in the base of the Lansing, top of the Mississippian, Viola, and Simpson. A series of isolated developments are rapidly merging into a single stratigraphic trap accumulation on the south-east flank of the Central Kansas Uplift. Schweizer is the most northerly of five producing localities on the Peace Creek trend, and was discovered in February. The Smyres pool produces from the Mississippian chat. The Ray pool has been extended westward in the Reagan sand. At Lindsborg, which has also been extended, the Viola yields oil.

There are a series of north-east to south-west trends south of the Central Kansas Uplift, and a major trend parallel to the main high from Zenith north-west, and another parallel trend is developing from Cunningham at least into Pawnee County. However, many of the pools on the subsidiary trends were abandoned or had small quantities of gas and were not developed beyond the two-well stage.

A map shows the oil and gas discoveries in Kansas during the first half of 1942.

G. D. H.

768.* May Completions Hold Steady at Rate of 45 Daily. Anon. *Oil Gas J.*, 18.6.42, **41** (6), 84.—1421 wells were completed in U.S.A. in May, 846 being oil-wells. During May 1941 2669 wells were completed, 1879 being oil-wells and 554 dry. The indications of May 1942 are that wildcatting is still relatively near the 1941 level, but that the 40-acre spacing for oil-wells and the 160-acre spacing for gas-wells have greatly curtailed developmental drilling.

There were thirty-six more completions in Illinois in May than in April, and thirty-two less in Kansas. There was little change in the other States. The new Paluxy discovery in East Texas and the Tuscaloosa find in East Central Louisiana will probably increase wildcatting in those sectors.

The May operations are summarized by States and districts with the number of completions, oil, gas, or dry, the numbers in certain depth ranges, the footage drilled, and the number of wells drilling. G. D. H.

769.* Pressing Development Work in Alberta. Anon. *Oil Wkly*, 29.6.42, **106** (4), 46.—Areas not yet developed along the 20-ml. proven length of the Turner Valley oil-field are being intensively drilled. Efforts are being made to extend the field both north and south. In the northerly extension a well has been drilled into the upper and lower porous producing zones of the Madison. This well is on the east flank of the structure.

Outside Turner Valley the main contribution to increased production has been from Vermilion, where there are sixteen producing wells. G. D. H.

770.* Discoveries in Los Angeles Basin Fail to Maintain Reserves. L. P. Stockman. *Oil Gas J.*, 2.7.42, **41** (8), 54.—The Los Angeles Basin had produced 2,834,508,909 brl. of oil up to the end of May 1942. All but a very small proportion of the production has been obtained from the Repetto (L. Plioc.) and the Puente (U. Mioc.), except at Long Beach, Inglewood, and Potrero, where the Pico (U. Plioc.) is productive. The basin has four structural trends parallel to the coast, and each trend has several fields. These trends are the Beverly–Newport line of shearing, the Playa del Rey–Wilmington trend, the Brea-Olinda–Montebello trend, and the Coyote Hills uplift. The Los Angeles Basin resembles the San Joaquin Valley in having many fields on the rim of the basin, accumulations following well-defined lines of folding and faulting, and general structural trends running north-west to south-east.

In the last ten years discoveries in the Los Angeles Basin have been few and far between, Wilmington being the only major discovery. Deep drilling revealed additional zones at Montebello and extended Dominguez westwards in 1939. In 1940 the Miocene Sentous zone was found to be highly productive at Inglewood, but the slow development has prevented its assuming importance. Turnbull Canyon, discovered in 1941, is only of secondary importance. The structure is a plunging, faulted nose cut off by a fault, with oil at about 3500 ft., probably from the Sycamore Canyon sand (U. Mioc.).

This year oil has been found at Buena Park at about 8900 ft. It is believed to be on a north-westerly-plunging nose, and may be from the equivalent of the Bell zone (Plioc.).

Unless a new line of folding is discovered it seems unlikely that many major discoveries will be made. Recently there has been a tendency to explore the rim of the basin, and in the east, where only relatively shallow drilling is necessary, previous work has shown heavy oil with doubtful commercial possibilities.

The area between El Segundo and Playa del Rey is to be tested, and deep sand production may be sought in the old Salt Lake field. Many believe that deep pays exist in the old Los Angeles City field. Only one well has been completed at Yorba Linda. This gave 766 brl. of oil and 276,000 cu. ft. of gas/day from a depth of about 2300 ft. A deep test is being drilled at West Coyote.

The Los Angeles Basin fields are listed with the discovery date, number of producing wells, cumulative production up to the end of 1941, type of structure, depth, oil gravity, and average pay thickness. G. D. H.

771.* South Kansas Discoveries Open Shallow Pennsylvanian Trend. Anon. *Oil Gas J.*, 9.7.42, **41** (9), 56.—The discovery of Lansing–Kansas City lime production in the Lake City field proves a new trend running from Sun City in the north-west to Medicine Lodge in the south-east, a distance of some 20 ml. The new Pennsylvanian discovery at Lake City was in an old well plugged back from the Arbuckle. Sun City, 10 ml. to the north-west, also produces from the Pennsylvanian, the discovery well again having been plugged back from the Arbuckle.

The third Pennsylvanian sand discovery well on this new trend is ½ ml. south of the Whelan Mississippian chat pool. This was completed in the Elgin sandstone with an initial potential of 3,900,000 cu. ft. of gas/day.

A table summarizes the geological data for the three Pennsylvanian discovery wells in northern Barber County, Kansas, and a map shows the positions of the wells. G. D. H.

Geophysics and Geochemistry.

772.* **Resistivity Method of Locating Oil and Gas Pays.** J. L. Harper. *Oil Gas J.*, 11.6.42. **41** (5), 64.—Electrical resistivity exploration has been carried out in and near oil-fields in various parts of the U.S.A. and Canada, the areas examined including rocks of most ages from Tertiary to the Cambrian. Both alternating and direct current were used, being supplied by a generator or batteries respectively. The best results were obtained with direct current.

The field procedure is briefly described, and a short account is given of the results of some of the investigations.

Under average field conditions 150–250 ft. in depth penetration can be done in an hour after the station is set up, and three to five stations can be occupied in a day. Depths of over 7800 ft. have been examined, and oil and gas can be located from the surface before drilling, the depth of the accumulation being indicated quite accurately. However, it is not known whether or not this can be done under all geological conditions.

G. D. H.

Polymerization and Alkylation.

773.* **Economics of the Alkylation Process in the Production of High Octane Gasoline.** R. G. Lovell. *Petrol. Engr*, March 1942, **13** (6), 27.—When planning the installation of an alkylation plant a survey of the availability of butylenes and *iso*butane in plant products must first be made. Consideration must then be given to the largest amount of butylenes which can be economically segregated for alkylation purposes, as this will determine the size of the plant to be installed. The surveying method is illustrated by considering hypothetical outputs and analyses of cracked gases, pressure distillate, and straight-run gasoline from a conventional refinery operating primary distillation and cracking plants and equipped with vapour-recovery systems. The availablity of butylenes will depend on such plant factors as depth of cracking, vapour pressure of stabilized pressure distillate, blending agent employed, etc. The quantities of *iso*-butane available from vapour-recovery systems, stabilization of the straight-run gasoline and of pressure distillate, should next be ascertained. If these quantities are insufficient to balance the butylenes available, the suggestion is made that a natural gasoline of 26–27 lb. Reid vapour pressure be obtained, stabilized in the plant to about 14 lb. vapour pressure, and the additional *iso*butane required extracted from the overhead product in a depropanizer–debutanizer unit. By taking a naphtha cut on primary distillation in addition to the gasoline and blending the mixture with the stabilized natural gasoline, an increase in the amount of straight-run gasoline base stock for premium-grade motor fuel could also be obtained. Flow diagrams of the various units are provided.

R. A. E.

774.* **See Supply of Aviation Gasoline Enlarged Through Hydrofluoric Acid Alkylation.** Anon. *Nat. Petrol. News*, 29.4.42, **34** (7), R. 131.—The new process is summarized as one in which *iso*paraffin hydrocarbons are alkylated with mono-olefinic hydrocarbons in the presence of liquid HF. It is claimed that propylenes, butylenes, and pentylenes may be alkylated either singly or together, thus making possible the use of very large quantities of cracked gases. The reaction takes place in the liquid phase, and since liquid HF boils at 20° C., temperature must be kept below 20° C. at atmospheric pressure. In the batch process described liquid *iso*butane and liquid HF are introduced separately into a line and mixed by charging through a pump, the butylene, or butylene and *iso*butane, then being admitted to the line. The mixture passes to a cooler, where the reactions proceed, and then to a settling tank. The hydrocarbons are fractionated, unconverted material being recovered overhead. Alkyl fluorides, produced as side reactions, are decomposed in contact with granular NaF or HF, the recovered hydrocarbon being recycled.

H. G.

775. **Patents on Polymerization and Alkylation.** Anglo-Iranian Oil Co. E.P. 546,037, 24.6.42. Appl. 23.12.40. In a process for the polymerization of olefins for the production of motor spirit a solid phosphoric acid catalyst is used, composed of *ortho*phosphoric acid, copper *ortho*phosphate, and calcium *ortho*phosphate. The ratio

of *ortho*phosphoric acid to the copper *ortho*phosphate and calcium *ortho*phosphate is higher than the ratio 4 : 1 : 1, but not substantially higher than the ratio 8 : 1 : 1.

H. Wolthan. U.S.P. 2,281,613, 5.5.42. Appl. 13.3.41.—Polymerization of a material selected from the group consisting of butadiene—1·3 hydrocarbons and mixtures of butadiene—1·3 hydrocarbons with copolymerizable compounds having a single C⊐C double linkage in aqueous emulsion in the presence of mercaptans having at least 6 carbon atoms in aliphatic linkage.

C. N. Kimberlin. U.S.P. 2,281,979, 5.5.42. Appl. 21.10.39. Process for the removal of over-polymerized constituents from polymerized oils by treating with a mixture of low-boiling petroleum hydrocarbons and a light oil boiling in the lubricating range.

K. Smeykal and K. R. Leuna. U.S.P. 2,282,499, 12.5.42. Appl. 1.9.38. Improved method of depolymerizing polymers of low-boiling olefins by passing them at an elevated temperature over a surface-active clay catalyst in which the clay itself is the effective catalytic component. Depolymerization is effected in the presence of an appreciable amount of steam, which operates on the clay itself to maintain the catalytic activity thereof. H. B. M.

Drilling.

778.* Drill Stem on Rotary Rig Cleaned with Steam. Anon. *Petrol. Engr*, June 1942, **13** (9), 44.—The pipe in the rat-hole is belled at the top and steam is connected to it. When the drill-stem is run into the rat-hole at the beginning of a trip out of the hole, or when waiting to set in another joint of drill-pipe, it is steam-cleaned as it is run in to remove drilling mud, old lubricant, etc. Part of the waste cleaned from the drill-stem and mud from the rotary hose drain down into the rat-hole pipe, and part drains off to the side beneath the rotary floor through a number of holes about 2 in. in diameter cut with a torch. When the rat-hole fills to the surface of the ground it overflows on to the ground through the 2-in. holes. A. H. N.

Transport and Storage.

777.* Reducing Internal Corrosion of Gasoline Pipe-Lines. W. A. Schulze, L. C. Morris, and R. C. Alden. *Oil Gas J.*, 6.11.41, **40** (26), 172.—Although some 12,000 miles of gasoline pipe-line is in existence in the U.S.A., most is of recent construction, and only thirteen companies operate lines of more than 200 miles in length. Methods adopted by them for combating internal corrosion of the line are tabulated. Apart from procedure designed to reduce the quantities of air and water entrained and the use of scrapers, three methods utilized are : (*a*) removal of oxygen by means of sodium sulphite, (*b*) removal of water by dehydration of gasoline, (*c*) use of mercaptobenzothiazole (Rokon) dissolved in the gasoline as corrosion inhibitor.

One company previously using sodium sulphite has now discontinued the practice, and another, whilst still injecting, reports little tangible proof of the value of the addition. One company which reduces the moisture content of products pumped by 40/50% by means of bauxite has found the process beneficial, but it is pointed out that a disadvantage may arise due to introduction of water into the line during maintenance and retention of water in sections of line in hilly country.

The experiences of 2 years' operation with inhibitor added to gasoline at two pumping stations on a long line are recorded. Observations were made on test-bars weighing 500 gm. prepared from the same steel as the line, and inserted in the line at distances up to 100 miles from the injecting stations, and comparative observations were made on a section of the line more distant from the inlet end and where no inhibitor was injected. The results show very little corrosion of bars up to 100 miles from the injection point, but increasing with distance from that point in the case of inhibited gasoline. Bars in the uninhibited section showed rather severe corrosion. Losses in weight of bars after scale removal expressed as percentage per annum were nil from an inhibited section and 2–2·5 for uninhibited sections. Measurement of rust and scale from sediment traps on the intake side of pumping stations over a period of 6 months yielded comparable results, although differences in scraper usage and

flow rates may have contributed somewhat to differences in scale removal in various sections of the line. Examination of a small number of pipe-sections removed tends to confirm the value of the inhibitor, and so a third inhibiting station is shortly to be installed. Since the life-period of the inhibitor will vary with the type of gasoline pumped, careful control is necessary to decide the length of line which one station may protect. Intermittent injection may produce the desired effect, but further research on these problems is required. Another company using the process on a 50-mile section of 6-inch pipe-line found that it gave increased line capacity with reduced scraper usage, but that the cost of the inhibitor plus injection expenses did not justify its use. The economics of inhibitor usage are discussed. R. A. E.

778.* **Method of Determining Pipe-Line Corrosivity Due to Soils.** Paul F. Marx. *Petrol. Engr*, Feb. 1942, **13** (5), 29.—The theories of a variety of authors are discussed and the principles of J. F. Putman are used to derive a fundamental equation connecting corrosivity with the specific resistance of the soil.

An instrument (of which a photograph is given, but which is not described) has been developed to establish the degree of corrosion and to predict pipe-life. Correlation of results given by the instrument and by U.S. Bureau of Standards pipe specimens shows that it should have practical use in construction and reclamation programmes.

A variety of data obtained with different soils, etc., are given in graphic form.

J. C.

779.* **A Practical Application of Zinc Anode Protection to an 18-in. Pipe-Line.** C. L. Brockschmidt. *Petrol. Engr*, Feb. 1942, **13** (5), 74.—A detailed description, with many graphs, of a successful protective installation to a pipe-line in highly corrosive river-bottom land. Seven years after laying, the pipe-line began to spring leaks with increasing frequency and zinc anodes were finally installed.

Data obtained are given in the form of curves showing (*a*) soil-resistivity profile of terrain, with data bearing on the corrosion problem, (*b*) and (*c*) pipe/soil potential profiles for a series of six surveys made over a period of 830 days from the time zinc was connected, (*d*) current output of each cell of ten anodes, (*e*) and (*g*) zinc/soil potential, (*f*) open-circuit voltage zinc/pipe. Much of the data is also tabulated.

A few general suggestions are made for improvement in future installations.

J. C.

780. **Practical Methods for Storing Volatile Liquids.** D. E. Larson. *Nat. Petrol. News*, 1.4.42, **34** (13), R. 105.—The subject is discussed principally from the point of view of the minimizing of losses which are discussed under different headings. Sundry charts, which are reproduced, permit losses to be calculated and facilitate the choice of the most suitable type of storage. A means of assessing storage costs is also given. The classes of service to which the basic types of storage are best suited are: 1. Atmospheric tanks with fixed roofs and conservation valves for fuel oil, kerosine, low-volatility products. 2*a*. Breather roofs for gasoline in tanks that remain full or nearly full. 2*b*. Balloon roofs of large volume for gasolines in slow-working tanks. 3. Floating roofs for gasolines in tanks that work either continuously or intermittently. These roofs offer maximum fire production. 4. Pressure tanks are the only practical means of storing natural gasoline and similar light products. 5. Underground storage is so expensive as to be justified only on the grounds of national security or because of city regulations. H. G.

781.* **Savings from Painting of Gasoline Storage Tanks.** Anon. *Oil Gas J.*, 16.4.42, **40** (49), 51.—Tests conducted in the New York City area over an entire summer period on tanks filled with regular grade gasoline and having standard gooseneck connection showed the following losses expressed as percentage by weight: painted black, 9·2%; unpainted (average), 8·4%; painted aluminium, 7·28%; painted white, 5·60%; sunshaded, 5·18%. In the case of a 1000-brl. tank, it is estimated that the cost of labour and material for painting the whole tank white would be paid out in one and a half summers by the value of the gasoline saved, assuming the white paint has no effect on evaporation losses in winter months. Painting the roof only would be paid out in just over half a summer on a similar basis. R. A. E.

Crude Petroleum.

782.* Viscosity of Crude-Oil Emulsions. Wm. Woelflin. *Oil Gas J.*, 19.3.42, **40** (45), 35.—Viscosity determinations were made mainly on brine-in-oil emulsions of both small and large particle size. The apparatus consisted of a reservoir with a paddle-stirrer from which a uniform mixture flowed to a funnel, the rate of flow being adjusted to keep the funnel constantly overflowing. The time of efflux of 100 ml. of sample was measured. Results were correlated with Saybolt Universal seconds by means of determinations with transformer oil, glycerine, and various crude oils, using the A.S.T.M. viscosity–temperature chart to convert observed viscosities to the same temperature. There is a straight-line relationship between Saybolt and funnel viscosity. Results are expressed in terms of "viscosity ratio"—*i.e.*, the ratio of the viscosity of the emulsion at any temperature to the viscosity of the clean oil at the same temperature.

Using artificially made emulsions, the effects of particle size and of brine content were determined, and are shown by means of curves. The effect of particle size becomes of importance only at over 30% concentration. With increasing brine content viscosity gradually increases to about 40% brine, then abruptly to about 70–80%, at which stage there is generally a phase inversion to brine as the external phase and brine-in-oil emulsion as the internal phase, causing a drop in viscosity to just above that of 100% brine. Near inversion point the viscosity is very high, and the emulsion at this point, especially if the brine is finely divided, can be considered as a plastic solid. The conclusion of practical importance is that crudes should be pumped at low brine content or at extremely high brine content, although the latter case will involve pumping a very large volume of fluid.

A few experiments carried out on temperature effect showed the viscosity ratio for a given brine content to be independent of temperature. J. C.

Gas.

783. The Thermal Properties of a Wet Gas. G. G. Brown and F. Kurata. *Petrol. Engr*, Dec. 1941, **13** (3), 23.—Enthalpy–entropy and temperature–entropy diagrams for wet gases, such as condensate, are presented, together with examples of the calculations necessary for their construction. The diagrams can be used for accurate calculations involving thermal properties—*e.g.*, the computation of the drop in temperature accompanying a free expansion. J. C.

784.* Eliminating Hydrate Formation in S. Texas. F. H. Dotterweich. *Petrol. Engr*, March 1942, **13** (6), 83.—Production of high-pressure natural gas in S. Texas producing areas is being accompanied by many problems relating to hydrate formation. The conditions existing, however, do not warrant the installation of dehumidifying plants in gathering lines, transmission systems or cycling plant operations. In most cases hydrate formation is induced only at infrequent short intervals, and heaters and heat interchangers are being employed. The work of Deaton and Frost is of great assistance in the design and operation of such equipment, and illustrations of the application of their data are given. In the removal of condensate in cycling plants three general methods are being used: (1) high-pressure oil absorption, (2) extreme cooling and separation with or without dehydration, (3) moderate cooling and separation. Application and operation of heaters and heat interchangers to permit satisfactory condensate removal and avoidance of hydrate formation are described. Insulation of the entire conditioning equipment to eliminate effects of variations in temperature and atmospheric conditions has been found to be of great value in a plant of the third type employing low-pressure oil absorption. The method employed in this plant for dealing with gases of varying character from different producing wells is also described. R. A. E.

Cracking.

785.* True Vapour Phase Process in Advanced Stage of Commercial Application. Anon. *World Petrol.*, 1941, Ann. Ref. Issue, **12** (11), 76.—In the T.V.P. process excessive gas formation is avoided by using as the heat medium for the vaporized

cracking stock a recirculated highly heated gas stream. A T.V.P. reforming unit recently constructed at Buffalo, N.Y., handles 1400 brl. of heavy and 800 brl. of light naphtha per diem, producing 91% of 401° F. E. Pt. gasoline of V.P. 9·3 lb. and O.N. 75·0. The addition of 1 c.c. of lead increases the O.N. to 82·5. The combined vapour-phase thermal cracking and pyrolysis of the recycle gas results in very complex reactions, including polymerization, isomerization, dehydrogenation, hydrogenation, and alkylation. The total cost of the plant is given as $100 per barrel of heavy naphtha processed, so that the process would appeal to small refineries unable to afford the high investment costs of modern catalytic and reforming processes. An interesting potentiality of the process is the production of butadiene by increasing the reaction temperature and reducing the reaction time, treatment of a Pennsylvanian gas-oil giving 5·03% of butadiene out of a total yield of 14·94% of C.4 fraction. A 10,000-brl./day unit would thus produce approximately 25,000 tons per annum of butadiene. Aromatics may be produced at lower temperatures and longer reaction times, yields of 3·28% and 3·65% of toluene being obtained from E. Texas gas-oil and 200/400 Ill. naphtha, respectively. Details of yields from a semi-commercial unit are given, yields of up to 94·5% of gasoline being obtained, while the gases introduced show up to 50% conversion to gasoline.

A new T.V.P. cracking process has been worked out to operate on a reduced crude, but no operating date is at present available. C. L. G.

786.* Polyform and Gas Reversion Processes. E. R. Smoley and V. O. Bowles. *Oil Gas J.*, 6.11.41, **40** (26), 143.—In the U.S.A. approximately 100,000 brl. a day of naphthas, propane, and butane are processed in polyform and gas reversion plants, of which fourteen are in operation and four under construction. A.S.T.M. octane ratings of gasolines which can be produced with satisfactory yields from various charging stocks are: from straight-run heavy naphthas 76–80, from gas-oils of all types 74–76, from reduced crude 70–72, from heavy cracked gasoline 76. Inclusion of propanes and butanes from refinery or natural gas sources is advantageous in processing and provides additional quantities of high octane gasolines; about one-third of feed to existing plants consists of C_3 and C_4 fractions. The spread between A.S.T.M. and Research octane ratings of the gasolines produced ranges from 9 to 14 points. Aviation fuels meeting Army specifications and having an octane rating up to 91 with addition of less than 4 mls. T.E.L. per U.S. gal. can also be prepared. A description of the naphtha polyform process with provision for intake of C_3 and C_4 fractions is given, together with flow-sheet diagram. The application of the process to cracking of crude oil is illustrated by flow-sheet and described. The plant considered has a crude capacity of 22,000 brl. a day and replaces the conventional type of crude topping and cracking unit, a thermal polymerization unit, and a gas compression and absorption plant. Crude is charged via heat exchangers and a heater convection bank into an atmospheric topping tower, and straight-run gasoline is removed from the top. Heavy naphtha and kerosine side-streams are withdrawn through stripping-towers, and below the kerosine draw-off a straight-run gas-oil fraction is removed. This gas-oil with admixture with propanes and butanes is charged directly to the gas-oil polyform coil, where 34–45% of gasoline per pass is obtained. Heavy reduced crude from the bottom of the atmospheric tower is charged hot to the polyform viscosity-breaking coil after admixture with a side stream from the heavy tar stripper and propanes and butanes. Conversions per pass of 14–16% are obtained. Light recycle stock from the base of the fractionating tower is charged to the recycle coil with admixed propanes and butanes, yielding 25–32% gasoline per pass. The C_3 and C_4 fractions for these three coils are obtained from the stabilizer overhead, and consist of approximately 25% butanes, 75% propanes. Heavy naphtha passes over the absorber to remove C_3 and C_4 recycle from the residue gas and the enriched naphtha is charged to the naphtha coil. All four coils discharge to a common separator tower, the bottoms from which pass to the tar stripper, where fuel of the desired gravity is removed as bottoms; overhead fractions pass to the bubble-tower, and a side stream is removed for admixture with reduced crude prior to entering the viscosity-breaking coil.

The economics of butane and propane conversion in a naphtha polyform unit are discussed, and an example is given of a method for obtaining high yields of 100-octane aviation base and 73-octane motor fuel from casing-head gasoline of 26 lb. vapour pressure. This method involves separation of *iso*pentane, *n*-butane, and *iso*butane,

followed by distillation to yield aviation base-stock and heavy naphtha. The heavy naphtha and *n*-butane would be charged to a polyform unit to produce motor gasoline and a butane/butylene fraction which would be charged to an alkylation plant, together with the *iso*butane, producing aviation alkylate and *n*-butane for recycle to the polyform plant. Blending of alkylate, *iso*pentane, and aviation base-stock provides the 100-octane aviation base. Yield-octane relationships obtained from plant data when operating on 45-octane number mixed Texas naphtha with additional propanes and butanes are presented, and similar data provided for Californian naphtha of 58 octane number from pilot-plant operations. R. A. E.

787. Patents on Cracking. G. C. Connolly. U.S.P. 2,281,919, 5.5.42. Appl. 6.12.38. Method of cracking hydrocarbon oil to form lower-boiling hydrocarbons which involves contacting the oil at cracking temperature with a catalyst comprising a composite gel of silica and alumina containing up to 1% of an oxide of an element of group II taken from the class consisting of beryllium, magnesium, and cadmium.

K. M. Watson. U.S.P. 2,282,273, 5.5.42. Appl. 7.6.40.—Method of conversion of hydrocarbon oil by catalytically cracking a relatively light oil in the presence of a powdered cracking catalyst and under sufficient pressure to maintain a substantial portion in liquid phase. The vapours are separated from the catalyst, and one portion of the catalyst containing liquid reaction products is returned to the cracking operation. Another portion of the liquid reaction products substantially free from catalyst is subjected to pyrolytic conversion, together with a residual hydrocarbon oil. Cracked vapours are fractionated from this conversion process to separate reflux condensate from the fractionated vapours and at least part of the reflux condensate is passed to the catalytic cracking stage.

H. E. Drennan. U.S.P. 2,282,602, 12.5.42. Appl. 15.3.38. Method of conversion of low-molecular-weight olefins to hydrocarbons of higher-molecular-weight, which involves contacting the olefins with a catalyst comprising a moisture-free mixture of phosphorus pentoxide and a metal oxide selected from the group consisting of the oxides of copper, magnesium, iron, zinc, aluminium, tin, and nickel. The mixture is previously calcined under moisture-free conditions with a binder which produces a carbonaceous residue on heating.

G. Egloff. U.S.P. 2,282,855, 12.5.42. Appl. 29.6.40. Process for the conversion of hydrocarbons which involves heating a flowing stream of the oil to be cracked to a catalytic cracking temperature, while maintaining a dispersion of finely divided catalyst in the said stream. The resultant heated oil and dispersed catalyst is passed to one end of an elongated reaction zone, and the resultant conversion products are removed from the other end of the zone. A portion of the conversion products and catalyst are returned to the reaction zone, and from the remaining portion are separated cracked vapours and catalyst containing residue. The vapours are fractionated to form a reflux condensate, and afterwards to condensation to form distillate and uncondensed gases. The distillate is recovered, and regulated quantities of the uncondensed gases are returned to the reaction zone.

J. E. Ahlberg and C. L. Thomas. U.S.P. 2,282,922, 12.5.42. Appl. 20.3.37. Conversion of hydrocarbons by cracking hydrocarbons heavier than gasoline in the presence of an alumina–silica catalyst resulting from the co-precipitation of hydrated aluminium and silicon oxides in an aqueous menstruum containing ammonium hydroxide. H. B. M.

Refining and Refinery Plant.

788.* Solvent Refining Units at Ponca City Refinery. Anon. *World Petrol.*, 1941, Ann. Ref. Issue, **12** (11), 81.—Duo-sol, furfural, and methyl ethyl ketone units for the solvent refining of motor and industrial oils have been installed at a Ponca City, Oklahoma, refinery. These are integrated with the centrifuge dewaxing process used to dewax oils, which has been modernized to utilize hexane as the solvent, and also with the Bari-sol process. The Duo-sol plant handles 1600 brl. per day of heavy vacuum-distilled lubricating oil, and the furfural plant 1200 brl. per day of light wax distillate. The raffinate from the former is dewaxed in the hexane dewaxing

unit, and that from the latter in the methyl ethyl ketone plant. A 130° F. melting-point wax is produced from the M.E.K. crude scale wax. The Company's motor oil contains methyl dichlorostearate for greater film strength and thialkene to reduce oxidation tendencies. C. L. G.

789.* Obtaining Asphalt Flux by Reducing Michigan Crude Oil. J. C. Albright. *Petrol. Engr*, Dec. 1941, **13** (3), 82.—A skimming plant, operated by the Producers Refining, Inc., to produce a variety of products, is briefly described. It utilizes a Michigan crude of mixed base, predominantly asphaltic, processing 2500 brl. daily. A variety of overhead and side streams are yielded, together with a residuum of 15° A.P.I., part of which goes to the vacuum reduction side of the refinery. The various conditions of operation—for example, temperature and degree of vacuum—to produce different products, such as S.C. 5 and S.C. 6, from the bottoms, are quoted. J. C.

790.* Blending to Improve Refinery Products. R. G. Lovell. *Petrol. Engr*, Feb. 1942, **13** (5), 41.—It is demonstrated how, after debutanization, the residual pentanes plus may have their vapour pressure raised to normal requirements by blending in *n*-butane, remaining from the de-*iso*butanizing operation. This, incidentally, will have a beneficial effect on the octane number. Curves are presented showing the amount of a natural gas component that can be substituted for another component without altering the vapour pressure.

Boiling ranges of blends can be predicted, less accurately, by an involved method of calculation, or by an easier graphical method.

It is shown how slight alterations in methods of plant operation may help to give bottoms of desired characteristics, when recovering *iso*butane and butylenes.

Other advantages of control of distillation range, etc., which are not indicated by the ordinary knock characteristics, have been demonstrated by the author by means of a car fitted with a variety of unusual instruments, enabling the following to be observed :—

Temperatures of :—

- Gasoline in carburettor bowl.
- Air to carburettor.
- Gasoline–air mixture at carburettor discharge.
- Gasoline–air mixture at front–centre–rear of intake manifold.
- Exhaust gas from each cylinder.
- Exhaust gas composite.

Barometric pressure.
Air saturation.
Intake manifold vacuum.
Power (relative in terms of equivalent grade).
Air–fuel ratio ; each cylinder and composite.

Comparative, controlled tests with this mobile laboratory have shown that narrow distillation range and a low 90% figure and final boiling point gave a distinct improvement in performance, and it is considered that the better behaviour of the fuel in the engine is due to more complete atomization.

*iso*Pentane has an octane number of 89 and *n*-pentane of 69, so that substitution of *n*- by *iso*- would be advantageous. It is suggested that *iso*pentane be added to butane and pentane-free stock to bring up the O.N., distillation range, vapour pressure, and gravity to such points that the specifications for 91 octane gasoline are met by adding the maximum amount of tetraethyl lead. Since *iso*- and *n*-pentane differ only little in vapour pressure and boiling point, separation would be difficult, requiring many trays, a high tower, and a high reflux ratio.

In general, response of hydrocarbons to tetraethyl lead depends on two factors: the base octane number and the chemical composition. The latter depends on the nature of the crude and the type of cracking practised with total sulphur content as the principal depressing factor in lead susceptibility. The sulphur compounds apparently react in the burning mixture to give lead sulphide, which is inactive as a knock suppressor. A chart is given showing the degree in which lead susceptibility is affected by the initial octane number of the base stock (assuming sulphur com-

pounds to be negligible). The effect of sulphur compounds is shown graphically from results obtained with a Californian straight-run, blends of this with heptene and blends of heptene with butyl mercaptan.

Some general inferences are made relating to the effects on the refining industry of the need for stock of high quality (other than cracked products) for aviation gasoline, and the consequent possibilities for the refiner. J. C.

791.* Complete Extraction of Liquefied Petroleum Gases. J. C. Albright. *Petrol. Engr*, Feb. 1942, **13** (5), 131.—A description, with a flow diagram, of a refrigerating or sub-cooling system, installed by the Cabot Carbon Co. at its Walton refinery, Texas, to obtain fuller extraction in the natural gasoline plant. Originally conventional practice was followed by absorbing the fractions from the rich gas by means of two absorbers in parallel, with the absorption oil and gas cooled to the lowest temperature practicable by ordinary atmospheric coolers—*i.e.*, about 90° F. This temperature was not low enough for complete extraction of propane and butane necessary for the production of L.P.G. (liquefied petroleum gases). An additional absorbing column, built in two sections, has now been installed, to follow the two primary absorbers. Only the oil is chilled (to a temperature of 50° F.), the refrigerant being liquefied propane. There is a series flow of gas from the base to the overhead outlet, but an oil-collecting tray removes the oil from the lower part of the upper section to be withdrawn and passed through another propane chiller (the temperature again being reduced to 50° F.), from which it is immediately returned to the top of the lower half of the absorber. The unabsorbed gas from the top of the secondary absorber is used for fuel and carbon-black production, whilst the absorption oil from the base passes to a still. J. C.

792.* Influence of Alloy Additions on Corrosion Resistance. C. L. Clark. *Oil Gas J.*, 19.3.42, **40** (45), 48.—Results, obtained under specific operating conditions, for corrosion resistance of steels to hot petroleum products are presented graphically. They indicate that exactly comparable results may not be obtained from A.P.I. strip specimens and from commercial tubes, but that both types of test show that increasing chromium content imparts increasing corrosion resistance. Increased silicon content and the addition of aluminium seem to improve the resistance of actual tubes to a greater extent than in the case of the strip specimens. The character of the crude and variations in operating conditions may shift the various curves, but it is considered that the steels will retain their relative order of merit, and the curves should therefore serve as a useful guide in the selection of steels for refinery service. J. C.

793.* New Grapeland Plant Features Flexibility in Operation. W. C. Westbrook. *Oil Gas J.*, 16.4.42, **40** (49), 33.—A description is given of the construction and operation of one of the newest condensate-recovery and gas-cycling projects in Grapeland field, East Central Texas. Facilities are provided for processing up to 53 million cu. ft. of wet gas daily, and the plant at present handles the output from six producing wells, residue gas from the high-pressure absorber being injected into one injection well by compressors at a pressure of 2500 lb. Separate flow-lines from each well deliver gas to individual primary separators for initial separation of heavier condensate fractions, which re-enter the system with the rich oil-stream to the high-pressure re-absorber. After passing individual meters, the combined gases from the separators pass to three absorbers, the first being the high-pressure absorber operating at 1600 lb. pressure. The rich oil-stream from this absorber is combined with condensate from the primary separators and passed to a scrubber, where hydrates are trapped, and from thence to a high-pressure re-absorber operated at 400 lb. pressure. The low-pressure re-absorber operates at 70 lb. pressure, and the flash-vapours from the high-pressure re-absorber and vapours from the depropanizer feed-tank are recycled for re-absorption and fractionation. A centrifugal pump feeds lean oil to the low-pressure re-absorber and to the suction of a high-pressure pump, which feeds the high-pressure absorbers.

The still operates at 80 lb. pressure and has eight trays in the stripping section and twelve in the fractionating section. The depropanizer and debutanizer are described. The kerosine stripper takes its feed and reflux from the stripper

section of the still, and is built into one column with the lean oil reclaimer, which is an atmospheric fractionator, the feed and reflux of which come from the hot-oil circulating header at 480° F. Overhead vapours from the reclaimer are condensed, and pass to an oil–water separator. The oil level is maintained by a liquid-level controlled pump delivering to circulation or storage. Lean oil for heating the still, strippers, etc., is circulated to the oil-heater from a surge-tank equalized in pressure and temperature with the bottoms of the still. Plant fuel-gases are supplied by the light fractions flashed in the high-pressure re-absorber. Auxiliaries, control methods, and safety devices are described. Maximum daily production expected is about 65,000 gal. motor fuel, 25,000 gal. butane, 2500 gal. kerosine, and 500 gal. fuel oil.

R. A. E.

794. The Performance of Refinery Gas Absorbers with and without Intercoolers. R. M. Jackson and T. K. Sherwood. *Nat. Petrol. News*, 29.4.42, **34** (17), R. 134.—Data, relative to full-scale refinery operations, are given for the operation of an absorber working on mixed gases. It is shown that the use of intercoolers increases recovery, the advantage gained being greater in the winter than in the summer, owing to the lower temperatures prevailing in the winter. The work afforded opportunity of comparing observed data with the results of standard calculation. It was concluded that, with the exception of calculations involving methane, agreement was good.

H. G.

795. Patents on Refining and Refinery Plant. U. B. Bray. U.S.P. 2,281,667, 5.5.42. Appl. 22.7.33. Method of refining petroleum oil which includes mixing the oil with liquefied hydrocarbon gases having a vapour pressure greater than atmospheric, cooling the mixture to a temperature sufficient to congeal the wax content, passing the cooled mixture through a settling tank, and afterwards separating from it the remaining portion of wax by filtration.

V. L. Chechot. U.S.P. 2,282,033, 5.5.42. Appl. 3.11.39. Process of refining viscous hydrocarbon oil which involves adding to it a small quantity of finely divided mica and talc and afterwards separating from the treated oil the mica–talc mixture containing entrained acid-sludge.

W. J. Mattox. U.S.P. 2,282,231, 5.5.42. Appl. 19.4.41. Method of separating ethyl benzene from a mixture containing essentially ethyl benzene and isomeric xylenes. The mixture is fractionally distilled to remove a relatively lower boiling fraction containing *m*- and *p*-xylenes and ethyl benzene from a residue of higher-boiling *o*-xylene. The relatively lower-boiling fraction is subject to catalytic hydrogenation to form a naphthenic hydrocarbon mixture, including *cyclo*hexane and dimethyl *cyclo*hexanes. The mixture is then separated by distillation into dimethyl *cyclo*hexanes and an ethyl *cyclo*hexane fraction, and the latter catalytically dehydrogenated to give ethyl benzene.

M. A. Dietrich. U.S.P. 2,282,710, 12.5.42. Appl. 14.6.39. Method of inhibiting the deterioration of hydrocarbons in the presence of metals normally active to catalyse deterioration. Incorporated in the petroleum hydrocarbons is a small amount of an organic compound having an amino nitrogen atom and a divalent sulphur atom, each singly bonded to adjacent aliphatic carbon atoms in open-chain configuration. The second valence of the sulphur atom is satisfied by a member of the group consisting of hydrogen and aliphatic radicals.

L. U. Franklin and W. H. Weeks. U.S.P. 2,284,273, 26.5.42. Appl. 20.7.39. Method of sweetening sour petroleum oils containing mercaptans by suspending in a flowing stream of the oil, in the presence of an oxygen-containing gas, a substantially dry solid mixture of asbestos, and a substance capable of reacting with the mercaptans to form sweet sulphur compounds, and of regeneration by the oxygen-containing gas.

W. H. Rupp and K. E. Thorp. U.S.P. 2,284,592, 26.5.42. Appl. 23.3.40. Process for the recovery and segregation of hydrocarbons containing three carbon atoms in the molecule and fractions containing four carbon atoms in the molecule derived from the cracking of petroleum oils.

C. D. Marshall. U.S.P. 2,284,607, 26.5.42. Appl. 3.10.41. Method of dewaxing a waxy petroleum oil-stock by admixing with it a solvent in amount to maintain the mixture fluid at temperatures near, but somewhat above, final dewaxing temperature. Then a second portion of solvent is added, and the mixture so formed finally chilled to dewaxing temperature and the wax separated therefrom.

H. B. M.

Metering.

796.* Dew-Point Recorder Utilizing Photo-Electric Relay Safeguards Gas Line Against Freezing. J. A. Setter. *Petrol. Engr*, Feb. 1942, **13** (5), 134.—A description, with a schematic diagram, of a novel dew-point recorder utilizing a General Electric photo-electric relay. Continuous readings are given of temperature at which condensation occurs when natural gas enters the Denver metering plant of the Colorado Interstate Gas Co. The gas passes through a gold-plated U-tube, immersed in a freezing solution, fitted with plate-glass windows, above which are mounted a General Electric light source and photo-electric relay. When the gas is chilled a film of condensate is deposited on the inside of the U-tube, reducing reflection to the photo-tube, which operates to disconnect the cooling coils and connect heaters to warm the solution. The process repeats when the condensate disappears, and a recording-bulb-type thermometer records the temperature of the solution, giving a curve similar to a sine wave. The gas pressure is also recorded on the same chart, and from the two records the dew-point is calculated.

J. C.

Chemistry of Physics and Hydrocarbons.

797. Heats of Isomerization of the Nine Heptanes. E. J. R. Prosen and F. D. Rossini. *Bur. Stand. J. Res., Wash.*, 1941, **27** (6), 519–528.—Calorimetric measurements have been made which yield values for the differences in the heats of combustion of all the nine heptanes except 2-methylhexane and 3-methylhexane for the liquid state at 25° C. Values for these two in reference to *n*-heptane were determined from the corresponding values for the differences in the heats of combustion of *n*-hexane, 2-methylpentane, and 3-methylpentane, and of *n*-octane, 2-methylheptane and 3-methylheptane. These values for the differences in the heats of combustion which are also the heats of isomerization in the liquid state at 25° C. have been combined with calculated values for the differences in the heats of vaporization to give values for the heats of isomerization in the gaseous state at 25° C.

A description of the preparation of the heptanes is given. The calorimetric procedure was the same as that in the work on hexanes previously reported. The following values were obtained:

Isomer.	Heat of isomerization ΔH for $nC_7H_{16} = iC_7H_{16}$.		
	Liquid.	Gas.	
	25° C. k.-cal./mole.	25° C. k.-cal./mole.	0° K. k.-cal./mole.
n-Heptane	—	—	—
2-Methylhexane	− 1·30 ± 0·25	− 1·80 ± 0·29	− 1·21 ± 0·31
3-Methylhexane	− 0·72 ± 0·25	− 1·18 ± 0·29	− 0·42 ± 0·31
3-Ethylpentane	− 0·14 ± 0·23	− 0·52 ± 0·27	+ 0·48 ± 0·30
2 : 2-Dimethylpentane	− 3·42 ± 0·28	− 4·45 ± 0·32	− 3·40 ± 0·34
2 : 3- ,, ,,	− 2·18 ± 0·26	− 2·80 ± 0·30	− 1·71 ± 0·32
2 : 4- ,, ,,	− 2·54 ± 0·16	− 3·40 ± 0·22	− 2·32 ± 0·25
3 : 3- ,, ,,	− 2·44 ± 0·15	− 3·24 ± 0·21	− 2·23 ± 0·24
2 : 2 : 3-Trimethylbutane	− 3·00 ± 0·22	− 4·17 ± 0·27	− 3·02 ± 0·30

D. L. S.

798. Free Energies and Equilibria of Isomerization of the Butanes, Pentanes, Hexanes, and Heptanes. F. D. Rossini, E. J. R. Prosen, and K. S. Pitzer. *Bur. Stand. J. Res., Wash.*, 1941, **27** (6), 529–541.—Values are reported for: (*a*) the standard-free energy of isomerization divided by the absolute temperature $\frac{\Delta F^\circ}{T}$, (*b*) the relative amounts of the several isomers present when at equilibrium with each other for the two butanes, three pentanes, the five hexanes, and the nine heptanes, all in the ideal gaseous state for the range 298–1000° K. The results are presented both in tabular and graphical form. Comparison is made of these calculated values of the equilibrium concentrations with the directly measured values reported by other investigators for equilibria involving the two butanes, two pentanes, and four hexanes.

It is concluded that at 298° K. the normal isomer is thermodynamically the least stable in each case, with the exception that 3-ethylpentane is less stable than *n*-heptane. Relative to the other isomers, the normal isomer increases in stability with increase in temperature, and at 1000° K. is among the most stable of the isomers.

At 298° K. the 2 : 2-dimethyl isomer is in each case the most stable, but it rapidly becomes less stable with increasing temperature, and at 1000° K. is among the least stable of the isomers. D. L. S.

799. The Alkyl Nitrates. Anon. *Chem. Tr. J.*, 9.1.42, **110**, 35.—Sharples Solvent Corporation in E.P. 540,150 of 1940 describe an improved method for production of alkyl nitrates, particularly applicable to manufacture of propyl and amyl nitrates. The process comprises treatment of an aliphatic alcohol with nitric acid of 35–68% concentration, removing the nitrate by azeotropic distillation under a reduced pressure, and returning or adding to the reaction mixture that component of the reaction products which is in excess of the equimolecular proportion in the distillate, so as to remove both products of reaction in equimolecular proportions and to prevent an accumulation thereof in the reaction mixture. Auto-oxidation in the esterification vessel is prevented by removing the alkyl nitrate from the vessel promptly after formation. Urea solution is also added periodically in quantities sufficient to inhibit oxidation. R. A. E.

800. Chlorinated Olefins. *Chem. Tr. J.*, 20.2.42, **110**, 207.—E.P. 542,086 of 1941 issued to Shell Development Co. of California describes a method for halogenation via substitution of unsaturated aliphatic hydrocarbons with the aid of a catalyst at temperatures about 300–310° C. in the presence of less than 2–3% oxygen. R. A. E.

Analysis and Testing.

801.* Test Methods for Control of Gasoline Treating Processes. A. W. Trusty. *Petrol. Engr*, Jan. 1942, **13** (4), 58.—The effect of excess sulphur and polysulphides on the lead susceptibility and gum-inhibitor requirements of gasoline has emphasized the necessity of proper treating. Several easy methods of testing stock, developed as aids to the refiner, are described. These comprise :—

(1) Hydrogen sulphide in raw stock by reaction with acidified cadmium chloride solution.

(2) Mercaptan content of sour stock, by two methods :—

(*a*) The "copper number" test: addition of ammoniacal cupric sulphate to the H_2S-free stock until the blue colour persists.

(*b*) Addition of excess silver nitrate solution and back titration with ammonium thiocyanate.

A knowledge of mercaptan content is valuable in copper chloride treating, in caustic washing, and in doctor treatment. In the latter treatment it acts as an index of the correct quantity of free sulphur for making the "break."

(3) Litharge in Doctor Solution by acidification with acetic acid and titration with ammonium molybdate, using tannic acid as indicator.

(4) Butyl-mercaptan test. Addition of this reagent gives an orange or brown precipitate if the gasoline contains corrosive sulphur.

(5) Peroxides in gasoline by means of thiocyanate.

In addition, methods are described for the analysis of caustic soda containing sodium sulphide and mercaptides, using potassium iodide–iodate reagent. J. C.

802. Fluorescence Analysis Reaches Practical Development Stage. F. B. Taylor. *Oil Wkly.*, 22.6.42, **106** (3), 27.—The fluorescence shown by oil has been used to detect oil in mud streams, in cores, old and new, and in the examination of lubricants and lighter stocks.

Ultra-violet rays striking an atom may drive an electron into a new orbit, and the return of the electron to its former orbit may give out energy in the form of light. Not all atoms can give rise to fluorescence, and certain wave-lengths of ultra-violet light are needed to cause fluorescence in those substances capable of giving it.

Several sources of ultra-violet rays are available. Observations of fluorescence must be made in the dark.

Experience is necessary to interpret the meaning of differences in the fluorescent colours. It may be necessary to dissolve the oil in a solvent in order to observe the fluorescence. In some respects the method is over-sensitive, and therefore all indications must be interpreted according to the circumstances. Thus cores too tight to give commercial production may give brilliant fluorescence.

Substances other than oil may give fluorescence. G. D. H.

Motor Fuels.

803.* Sulphur Limits in Gasoline. Lowry and Egloff. *Oil Gas J.*, 11.12.41, **40** (31), 52.—A reasoned plea is made for the relaxation of sulphur restrictions in gasoline, and is backed by reference to many well-known authorities.

In parts of U.S.A. there is still in operation a sulphur maximum of 0·1% for gasoline. This low limit was derived arbitrarily at a time when the sweet, relatively sulphur-free crudes of the East and Mid-continent were abundant and were the main sources of motor fuel. The newer, cracked spirits from Texas, California, etc., caused antipathy because they differed in colour, odour, gravity, and sulphur content, but in all respects except sulphur the prejudice has been overcome. Strong evidence is presented that only free sulphur and mercaptans are harmful, and these are invariably removed by careful refiners. Other sulphur compounds, such as thiophenes, are harmless. Actual corrosion in motor-car engines is shown to be due mainly to water condensation, and in present-day cars is prevented by control of jacket-water temperature and ventilation of the crankcase. A wide variety of examples of the use of high-sulphur-content gasolines, without deleterious effects, are quoted, including an abnormal example of a mixture containing 5% carbon disulphide, which caused no damage. Further arguments are based on diesel-fuel specifications, and perhaps the authors' strongest point is the fact that high-sulphur-content spirits have been used on the West Coast for 15 years, in all kinds of climates, without causing any unusual wear.

It is necessary to raise these unjustifiably low sulphur limits to prevent wastage of natural resources through excessive refining of motor fuel. J. C.

804. New Specifications Issued by British Petroleum Mission. Anon. *Nat. Petrol. News*, 24.12.41, **33** (52), R. 408–R. 410, R. 416—Revised specifications for twenty-one products, including four new ones, have been issued by the British Petroleum Mission in Washington governing requirements of the British Government under lease–lend arrangements. The four additions concern finished alkylate for blending into 100-octane aviation gasoline, low-cold test distillate or residuum for lubes, Columbian lube distillate, sodium–naphtha–sulphonate (soluble cutting-oil base). The specifications are given in full, together with a list of the official test methods. The following specifications are unchanged: pool motor gasoline, white spirit, gas oil, diesel oil, marine diesel, marine fuel, W/D gas oil, special refinery gas oil, and Admiralty fuel oil. H. G.

805. Indian Power Alcohol. Anon. *Chem. Tr. J.*, 30.1.42, **110** (2854), 125.—Increased attention is being paid to the use of power alcohol from molasses as a blending

agent to conserve motor-spirit supplies. Schemes operating or under consideration aim at including up to 20% of alcohol. Admixture of alcohol has been compulsory in Mysore State since October 1939, and in United Provinces since 1940. Similar schemes are planned for Bombay. Much of the molasses from the 150 or more sugar factories in India is at present wasted. An expert committee appointed by the United Provinces and Behar estimated alcohol production costs to be less than 6½ annas (8*d.*) a gallon if molasses cost 6 annas a maund (82 lb.) at distillery. With a normal annual consumption of motor spirit of about 100 million gal., admixture of 20% alcohol is of considerable national advantage. R. A. E.

806. British Specifications Revised for Aviation Fuel Base Stocks. Anon. *Nat. Petrol. News*, 1.4.42, **34** (13), R. 102.—The revised or modified specifications for petroleum products agreed with the British Petroleum Mission in Washington are given. Revisions occur in the specifications for the unleaded base-stocks of 100. 91, and 87 O.N. aviation fuel, special refinery gas oil, pool light and heavy fuel oil, The specifications for hydraulic and transformer oil are modified. H. G.

807. Patents on Motor Fuel. R. B. Day and E. R. Kanhofer. U.S.P. 2,283,851, 19.5.42. Appl. 31.3.41. Process for the production of gasoline by subjecting a combined feed to catalytic cracking, fractionating from the products of this operation, gasoline, light intermediate conversion products, and heavy intermediate conversion products. The heavy intermediate conversion products are mixed with light intermediate conversion products formed in a thermal cracking process, and the mixture is subjected to thermal cracking to form substantial quantities of gasoline.

B. S. Friedman and W. L. Benedict. U.S.P. 2,283,854, 19.5.42. Appl. 5.7.40. Production of a substantially saturated gasoline of high octane number by cracking a hydrocarbon oil in the presence of a powdered cracking catalyst and of a hydrogen-containing gas. Conversion products are separated into a hydrogen-containing gas, a gasoline fraction containing substantial amounts of unsaturated hydrocarbons, and a higher-boiling fraction. Part of the higher-boiling fraction is returned to the cracking operation. The gasoline fraction is combined with a hydrogen-containing gas and a naphthenic oil, and the mixture is subjected to contact with a dehydrogenating catalyst to form a substantially saturated gasoline. H. B. M.

Lubricants and Lubrication.

808.* Recovery of Used Lubricating Oils. V. Biske. *Petroleum*, Nov. 1941, **4** (7), 147.—It is considered that the bulk of used oil available for recovery will be that used in internal-combustion engines, turbines, transformers, and other electrical equipment. Types of contaminants present in these oils, their origin, and effects are briefly reviewed. Purifying methods involving settling or filtration are of value in prolonging the useful life of oils, but eventually the oil must be discarded on account of increasing content of contaminants of the soluble type.

At present numerous relatively small plants using a variety of processes, and limited in scope both as regards the type of oil which can be treated and the degree of restoration of quality, are engaged in the recovery of used oil. Treating losses and running costs are also greater for these relatively small plants as compared with those of large plants. It is therefore considered that recovery of used oils could be achieved more efficiently in petroleum refineries, with greater flexibility in respect of feed-stock and production of finished products. Careful segregation of the various types of used oil is expensive and complicated, and it is suggested that the more centralized distribution and use of fresh oils applying under present conditions would enable returning tank-cars or returnable drums to be used for the delivery of used oils to the refineries. Flushing oil used for cleaning tank-cars so used could be added to the material to be recovered. Exclusion only of compounded and black oils is considered necessary.

Broadly speaking, normal refining procedure could be adopted, involving distillation to remove diluent and separation of spindle and medium lubricating-oil distillates, leaving a residue of long residuum type. The diluent separated might be used for

diluting oils received in order to accelerate separation of insolubles and render the oil more easily pumpable, or used as cracking stock or for fuel purposes. The lubricating distillates could be refined by acid or solvent extraction as desired. Treatment of the residue may be difficult on account of the presence of asphaltic material, and if considerable quantities of additives or grease are present, refining may not be an economic proposition. It is realized that the scheme may involve degrading some of the high-grade components, and that production of certain special types of oil normally obtained from selected crudes would be impossible from the mixed used oils. Nevertheless, the oils so produced would command a considerable market. Other advantages of a centralized scheme are enumerated. R. A. E.

809.* Lubrication without Oil. A. H. Stuart. *Petroleum*, Jan. 1942, **5** (1), 9.—Efficient lubrication of steam-engine cylinders has been maintained by the use of a dispersion of colloidal graphite in water, the graphite producing an anti-friction surface on the cylinder walls and showing no sign of being carried over by the exhaust steam.

In the lubrication of bearings made of cotton fabric bonded by synthetic resin, addition of colloidal graphite to water reduces the coefficient of friction under conditions of high load or high speed. Good results have also been achieved by soaking the cotton fabric in a dispersion of colloidal graphite in water or other suitable medium before bonding with the resin. Curves relating maximum load to variation in speed under conditions of at least 5 hours' running without seizure under dry conditions show the improvement obtained by this treatment of the cotton fabric. With plain-water lubrication it is estimated that the seizing load is increased by 35% if the cotton fabric is first impregnated with colloidal graphite, and nearly doubled if colloidal graphite is also incorporated with the lubricating water. R. A. E.

810.* Engine Bearing Temperatures (Road Tests).—I.A.E. Research Committee Report. J. Spiers. *J. Instn. Auto. Engrs*, 1942, **10** (6), 129–156.—This report deals with tests on a 10-h.p. car, the engine of which was equipped with eighteen thermocouples in the sump, oilways, and bearings. In general, the results confirmed previous bench tests; the factors mainly influencing bearing temperatures are as follows, in order of importance:—

1. *Engine Speed.* Bearing and oil temperatures increase either linearly or at an increasing rate with increasing speed, and are substantially independent of load.
2. *Viscosity.* A change from S.A.E. 50 to S.A.E. 10 oil reduced the big-end bearing temperature from about 77° C. to 65° C. at 2000 r.p.m. and from 138° C. to 90° C. at 4000 r.p.m.
3. *Oil Temperature.* Reduction in oil sump temperature is reflected to a greater or less extent in bearing temperatures.
4. *Air Temperature.* 83–85% of any air temperature variation is reproduced at the engine bearings.
5. *Water Temperature.* Not more than 25% of any change in jacket temperature is reflected in bearing temperatures.
6. *Oil Pressure.* Increase of pressure, and consequently of flow, results in a small reduction in bearing temperatures. K. A.

811. Patents on Lubricants and Lubrication. C. F. Prutton. U.S.P. 2,281,597, 5.5.42. Appl. 25.6.37. Preparation of a lubricant consisting of a major proportion of a lubricating oil and up to 20% of a halogenated alkylated aromatic ketone.

D. R. Merrill. U.S.P. 2,281,705, 5.5.42. Appl. 3.1.40. Extreme pressure lubricant consisting of mineral lubricating oil and a small percentage of chlorinated Edeleanu extract.

U. B. Bray. U.S.P. 2,281,824, 5.5.42. Appl. 22.9.39. Manufacture of a lubricating oil containing a relatively small proportion of an alkaline-earth metal soap of a saponifiable organic acid to overcome the deposit of resinous and varnish-like materials in severe service internal-combustion engines. Additionally there is incorporated a small quantity of an oil-soluble alkaline-earth metal compound of a

thio-phenolic derivative to overcome corrosion conditions developed in the oil. The added constituents do not materially increase the viscosity of the original oil.

G. H. Von Fuchs and H. Diamond. U.S.P. 2,281,894, 5.5.42. Appl. 18.1.40. Preparation of a lubricating or electrical oil composition consisting of a highly refined mineral lubricating oil and dissolved therein a small amount of a highly cracked distillate oil, free from tar and selected from the group consisting of coking cycle stock and cracking coke blow-down oil. The composition is claimed to have greater resistance to oxidation than mineral oil.

C. F. Prutton. U.S.P. 2,282,343, 12.5.42. Appl. 1.3.39. Manufacture of a lubricant consisting of 80% mineral lubricating oil and 0·1–20% of both an oil-soluble, halogen-bearing, oxygen-free organic compound and an oil-soluble, organic oxygen compound.

E. W. Cook. U.S.P. 2,282,707, 12.5.42. Appl. 10.12.38. Lubrication of bearing surfaces at least one of which comprises an alloy having substantially the corrosion-susceptibility of cadmium–silver, cadmium–nickel, and copper–lead alloys. The lubricant has incorporated in it corrosion-inhibiting proportions of an oil-soluble organic metallic sulphide.

F. W. Downing and C. J. Pedersen. U.S.P. 2,282,513, 12.5.42. Appl. 19.5.39. Incorporation into a viscous petroleum oil normally subject to deterioration in colour of a small amount of an organic compound of the type of a Schiff's base, obtained by condensation of 1 mol. of an aliphatic polyamine containing at least two primary amino-groups directly attached to different carbon atoms of the same open chain with at least 2 mols. of an aldehyde, so that one and only one mol. of aldehyde reacts for each primary amino group of the polyamine.

S. R. Scalzitti. U.S.P. 2,283,581, 19.5.42. Appl. 22.1.40. Preparation of a lubricant consisting of 94% of an oily base, 3% of zinc sulphide well dispersed therein, 3% of barium sulphate for retarding decomposition of the zinc sulphide by overheating between movable parts of machinery.

B. T. Brooks. U.S.P. 2,284,258, 26.5.42. Appl. 6.1.40. Preparation of a lubricating composition consisting of a mineral lubricant and a small amount of an oleone.

H. B. M.

Asphalt and Bitumen.

812. Patents on Asphalt and Bitumen. E. Thelen. U.S.P. 2,281,728, 5.5.42. Appl. 9.3.39. Method of treating a charging stock of asphaltic crude and residue which involves first heating the charging stock to approximately 270° F. and then adding 0·4–1·2% of 22 Baumé hydrochloric acid. This is done under conditions designed to effect substantially complete absorption of free hydrochloric acid. Finally the mixture is air-blown at 425° F.

R. E. Burk. U.S.P. 2,282,703, 12.5.42. Appl. 28.10.36. Process for making asphalt which involves oxidizing petroleum residuum by heating and agitating in exposure to oxygen and thickening the material to the desired melting point and penetration. After oxidation there is incorporated a small amount of a naphthenate of a metal of the group consisting of cobalt, manganese, iron, lead, vanadium, and zinc.

H. B. M.

Special Products.

813. Patents on Special Products. W. J. Backoff, N. D. Williams, J. F. O'Loughlin, H. L. Moir, and J. S. Yule. U.S.P. 2,284,080, 26.5.42. Appl. 6.10.38. Preparation for use as a gum solvent and consisting of 50–90% of refined mineral oil boiling above the boiling range of kerosene and 50–10% of a mixture of esters of phthalic and benzoic acids, the esters boiling above 350° F.

H. B. M.

Coal and Shale.

814. Swedish Shale Oil. Anon. *Chem. Tr. J.*, 30.1.42, **110** (2854), 132.—A new method for shale-oil extraction being developed by the Svenska Skifferoljeaktiebolgat, and due to Dr. Ljungström, consists fundamentally of heating the shale *in situ*, and experiments are said to have given promising results. The shale-beds in Närke are estimated to be sufficient for production of about 100 million tons of oil, but as the oil content even in the richest beds is not more than about 6%, production costs in peace-time were too high to enable competition with imported liquid fuel. By the method proposed, a number of vertical bore-holes are made in the deposit; in some, electrical heating elements are installed, whilst others are used to convey oil vapours and gas into condensers at ground level. The average depth of the shale deposit is 17–18 metres. By suitable arrangement of heaters it is estimated that the quantity of shale heated in each boring would be 400 tons, the heating period 2½ months, and power consumption 40,000 kw.

To produce 30,000 tons of oil per annum would require 2700 electrically heated borings and the heating of 1 million tons of shale. R. A. E.

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Geology and Development.

815.* Science Beats Guesswork Finding Oil. Anon. *Petrol. Eng.*, July 1942, **13** (11), 56.—Geology, geophysics, geochemistry, or some combination of these scientific methods was used to locate 2399 of the wildcats drilled in 1941, and 471 of the wells found oil. Only thirty of the 801 wildcats located non-technically were successful. The reasons for drilling sixty-four wells, two of which were successful, are unknown.

Normally about one-tenth of all wells drilled each year are wildcats or wells sunk in the hope of finding new fields. This year, because of the shortage of steel, the total wells will probably number only half that for 1941. G. D. H.

816.* Wyoming Awaits More Favourable Conditions for Full Development. T. R. Ingram. *Oil Gas J.*, 16.7.42, **41** (10), 70.—Three new discoveries were made in Wyoming in the first half of 1942. Only two new discoveries were made in 1941 and four in 1940. The smallness of the number of discoveries is a consequence of the restricted wildcatting. Wildcatting activity is a reflection of political and economic conditions.

The first oil-well in Wyoming was completed in 1884 near a seep on the Dallas dome. The Shannon pool was discovered in 1889, and in 1906 the first well to the first Wall Creek sand at Salt Creek proved the presence of an important field.

To-day Wyoming has ample refining facilities, and pipeline connections with Colorado, Montana, Utah, Kansas City, Chicago, and other places.

Over 250 structures have been mapped in Wyoming, and eighty-five have been found to contain oil and/or gas in commercial quantities, although not all of them have been drilled, and many have not been tested through all the possible oil horizons. Seventy-seven structures have been developed commercially, forty-five being primarily oilfields. The cumulative production of oil up to the end of 1941 was 529,521,300 brl. The proven reserves are estimated at 248,480,000 brl.

Most of the fields are on anticlinal folds around the edges of large structural basins. Only three of the seventy-seven structures have been drilled to the basement. Many hidden highs may occur within the basins, and they may be capable of location by modern methods. In Western and South-western Wyoming there are many structures in the Tertiary. Tertiary production has been found at La Barge, Hiawatha, and Powder Wash.

In 1931 a flowing well was completed at Badger Basin in the Big Horn Basin at a depth of 8723 ft. in the Frontier. Deeper production has been found in a number of fields a considerable time after the development of the shallower horizons. Some structures which are barren in the shallower horizons are productive in the deeper horizons. The oil and gas possibilities below the Tensleep are practically unknown.

This year oil has been found in the Tensleep on the Pilot Butte dome at a depth of 6446 ft. Previously the area had given oil at 1255 ft., and gas from the Muddy at 3362 ft. Tensleep production was found at 4640 ft. in the Cody field, and a gas discovery was made at 2950 ft. in the Dakota on the Sherrard dome.

Tables show the deepest zones tested in the seventy-three producing structures up to the end of 1939, and the producing zones, discovery date, number of wells, average daily production, cumulative production, type of structure, depth range, average zone thickness, and oil gravity in the various oilfields in Wyoming. G. D. H.

817.* Gradual Drilling Decline Continued through June. Anon. *Oil Gas J.*, 23.7.42, **41** (11), 54.—During June 1309 wells were completed in the U.S.A., 119 fewer than in May. The decline in activity was mainly in field development. In June seven more gas-wells were completed than in May. Drilling was less than one-half of what it was in June 1941.

A table gives by States and districts the numbers and types of completions in June, together with the total footage drilled, the number of wells drilling, and the numbers of wells in different depth ranges. G. D. H.

818.* Record Number of New Fields Being Discovered. Anon. *Oil Wkly*, 20.7.42, **106** (7), 27).—At present none of the 173 new oil- and gas-fields discovered during the first half of 1942 seems likely to be exceptionally large or prolific. 106 new horizons have been opened up in established fields.

Two prolific Ellenburger discoveries were made in Ward and Andrews Counties, West Texas. Known highs between these two discoveries are to be tested in the near future. The Fullerton find in Andrews County is in the Clear Fork. Cambrian production has been found at Wentz, and some small Delaware discoveries have been made in Ward and Pecos counties.

In North Texas the Forrestburg prospect yields oil from the Marble Falls at 7176–7323 ft. North-west of Clingingsmith a prolific Bend producer has been drilled. In Jack County the Worsham-Steed Smithwick discovery has proved to possess a gas-cap.

In South-west Texas eight discoveries have been made this year in the Carrizo-Wilcox series of the Wilcox trend. The up-dip Wilcox trend now seems to be established as a source of production. The Yegua production at 7767 ft. at Alice, Jim Wells County, directs attention to the Vicksburg trend as a potential deep producer. The Black Oak prospect of East Texas had a good Paluxy well at 6262–6350 ft., and several nearby wells have passed good possible oil production in the sub-Clarksville at 4000–4100 ft.

Camp Eleven and Mercy are probably the most important of the eleven discoveries

on the Texas Gulf Coast. The major find in South Louisiana was Bay DeChene. Two new Wilcox fields were found in North Louisiana, and in one case gas-distillate was proved below the Wilcox, probably in the Paluxy.

Twenty-seven new fields were opened in Illinois, the shallow Boulder field, which gives oil from the Bethel, probably being one of the most important. A Trenton pool has been found in Madison County on the extreme west side of the basin. The Osage lime has proved productive in the old Hazleton area of Indiana.

The Midway Smackover field of South Arkansas has been defined to the north and south, and appears to be a narrow structure. At New London Cotton Valley production has been obtained at a depth of 5757 ft. Sweet gas has been discovered in the Cotton Valley at McKamie, Dorcheat, and Macedonia, fields which previously gave only sour gas from the Smackover.

None of the new Kansas strikes seems to be outstanding, and the same appears to be true of the Oklahoma discoveries. A shallow heavy-oil field was found on the west side of the San Joaquin Valley 3½ ml. west of North Belridge. Production is from the Miocene. Eight oil discoveries and two new horizon discoveries were made in Michigan. At Adams Monroe production was found at a depth of 4229 ft. Extensions have been made to the Reed City and Kawkawlin pools adding 600–1000 acres to each. G. D. H.

819.* Wells Deeper and Footage Off Less than Completions. Anon. *Oil Wkly*, 20.7.42, **106** (7), 19.—Although the number of completions in the first half of 1942 was 23·2% below that for the corresponding period of 1941, the footage was down by only 19·9% as the average depth per well increased from 2987 to 3118 ft. The 11,090 tests represented 34,586,883 ft. of drilling.

The bulk of the footage was in Texas, where it amounted to 37·7% of the U.S. total. Due to the 40-acre spacing rule, drilling at East Texas came practically to a standstill. West Texas, with 3,819,890 ft., led the State in both completions and footage.

Louisiana was the second most active State as regards footage, and its wells averaged 6584 ft. and totalled 3,391,135 ft. In South Louisiana the average depth was 8748 ft. Pennsylvania was third in terms of total footage with the wells averaging 1657 ft.

Alabama, Arkansas, Colorado, Georgia, Michigan, New Mexico, New York, and West Virginia showed increases in footage, and all these States except Colorado and Michigan had a larger number of completions.

Tables show the number of wells, total footage, and average depth each year since 1925, and the completions, footage, and average depth in the first halves of 1941 and 1942 for the various States and districts. G. D. H.

820.* Wildcatting Decline Smaller than Total Completion Slump. Anon. *Oil Wkly*, 20.7.42, **106** (7), 20.—During the first half of 1942 the U.S. wildcat drilling was only 9·2% less than in the first half of 1941. 12·8% of the completions were wildcats. Of the 1942 wildcats 193 were oil-wells and forty gas-wells, practically the same percentage success as in 1941. The successful wells opened 172 new oil- and gas-fields.

It is unlikely that the 4000 wildcats hoped for in 1942 will be attained. Kansas completed 56·4% more wildcats than in the first half of 1941, and 17·5% of the 183 wildcats found oil or gas. In Oklahoma 23·5% of the wildcats were successful. West Texas had seventy-eight wildcats, more than twice the number drilled during the first half of 1941. 36·6% of South Louisiana's wildcats found oil or gas, but North Louisiana had only 5·3% of successes. 39·9% of the U.S. wildcats were in Texas, 13·6% of them being successful.

A table gives the wildcat completions and results in the first half of 1942 for the various States and districts, and the numbers of wildcats drilled in the first half of 1941. G. D. H.

821.* Year's Well Completions Likely to Exceed Predictions. Anon. *Oil Wkly*, 20.7.42, **106** (7), 17.—The results of the first six months of 1942 show that the year's drilling activity may be greater than was generally expected. 11,090 tests have already been drilled. The weekly number of completions fell from January to April, but has risen since then. It seems likely that future reductions in drilling are more likely to be due to shortage of materials than to spacing regulations.

The total completions in the first half of 1942 are 23·2% below the 1941 figures. A smaller percentage (53%) of the completions were oil-wells, as compared with 1941 (60·1%). 25·1% of the wells were dry. There has been an enlarged percentage of deepened and input wells this year.

Among the six major producing and drilling States, Illinois suffered the greatest decline, a 43·7% decrease in completions in six months. Texas has a 32% decrease, California 30·9%, Oklahoma 25·4%, Kansas 24·6%, and Louisiana a 23·1% decrease.

Tables show by States and districts the cumulative completions for the first half of 1942; details of completions in June 1942; the weekly average completions in the first six months of 1940, 1941, and 1942; details of the activity at the beginning of July 1942. G. D. H.

822.* Sharp Increase Advocated in California Heavy-Oil Fields. L. P. Stockman. *Oil Gas J.*, 23.7.42, **41** (11), 18.—An increase of 80% in the development of the Californian fields producing oil of 23·9 gravity and under has been recommended for 1943. However, the present prices do not favour such increased development. The rehabilitation of heavy-crude wells is suggested as the quickest way of obtaining the increase.

13,311 wells are potentially capable of giving heavy crude, and of these 11,651 are producing, 861 shut down, and 799 idle. Increased prices would encourage owners to clean out and work over those producing and shut-down wells needing such treatment, if ample equipment were available.

On a five-acre spacing there is room for 600 new wells at Wilmington, and it is recommended that these new wells must be completed in the tar zone, upper and lower Ranger and upper Terminal zones, multiple completions being allowed.

A table gives the heavy-oil fields with the undeveloped acreage, average well depth, proposed spacing and number of new wells, ultimate well production, and recovery per acre. G. D. H.

823.* Alberta Tar-Sands Tapped to Meet Canadian War Needs. J. Montagnes. *Oil Wkly*, 27.7.42, **106** (8), 96.—The Athabaska tar sands are variously estimated to have 100,000,000,000 to 250,000,000,000 brl. of oil. They are saturated for thicknesses up to 225 ft., and may contain as much as 25% of oil by weight. The tar-sands cover an area estimated to be 10,000–50,000 sq. ml., although much of the sand is buried at depths which may be as much as 1800 ft. It is not considered feasible to mine the sand where buried. A good asphalt can be extracted from the sands.

An extraction plant started operations last year, and it produces crude oil which is refined to produce gasoline, fuel oils, asphalt, and coke. G. D. H.

824.* Argentina Extends Old Fields and Discovers New Areas. M. L. Villa. *Oil Wkly*, 27.7.42, **106** (8), 58.—In 1941 Argentina produced 22,013,472 brl. of oil, 6·8% more than in 1940. The Comodoro Rivadavia field was extended by the opening of the El Tordillo zone. Three dry holes were drilled in Santa Cruz territory. A fourth well found a large gas-flow consisting mainly of carbon dioxide.

15 ml. east–south-east of Plaza Huincul oil-sands were found 3200 ft. deep. In the Portezuelo zone 19 ml. west–south-west of Plaza Huincul oil and gas were found at a depth of 2730 ft., and three gas-sands deeper.

Oil-shows were met in a well 10 ml. north–north-west of Zapala. In the Senillosa zone good oil indications were found in the Lower Cretaceous. Shows were observed in a deep well on the Carrizal structure, 7 ml. south–south-east of the Barrancas discovery well. Oil-sands were found in a well 2 ml. north-west of Tupungato. In Southern Mendoza province dry gas was encountered in the Upper and Lower Cretaceous, and heavy oil in the Upper Jurassic.

7,768,776 brl. of oil were produced in Argentina during the first four months of 1942. Non-commercial shows of oil and gas were found in the La Heras zone of Comodoro Rivadavia. The importance of the Challaco zone has been established at Plaza Huincul.

Tables give production and drilling data. G. D. H.

825.* Exploration Progresses in Scenic West Indies. Anon. *Oil Wkly*, 27.7.42, **106** (8), 88.—So far the oil production is confined to the Motembo field of Cuba, where

7,600,000 gal. of naphtha are estimated to have been produced during 1941. Several tests were drilled in Cuba during 1941 without finding commercial production. Geological studies were carried out there and in Haiti. Tests are to be drilled in the Dominican Republic, one being on the Comendador anticline 75 ml. west of San Juan. Shallow tests are also planned for the Maleno anticline 6 ml. north-west of Azua near old wells which have produced. Drilling is expected to be undertaken east of the highly faulted Maleno structure, which has eight abandoned wells. G. D. H.

826.* **Large Decline Indicated in World Crude Output.** J. Logan. *Oil Wkly*, 27.7.42, **106** (8), 45.—The 1942 world oil output is expected to fall substantially below the record output of 1941. This is due to the destruction of much productive capacity in the Far East, to the probable inability of the Russians to maintain normal production, to the shutting off of part of Venezuela's normal market by submarine warfare, and to a probable decline in the U.S.A. output. The U.S.A. output may fall by 30,000,000 brl.

The world production in 1941 is estimated to have been 2,226,836,000 brl., 4% more than in 1940.

The production data of the various countries are given for 1941, and the outputs of the leading countries are compared for 1931, 1939, 1940, and 1941. The production in 1939, 1940, and 1941 is tabulated for the countries of the Far and Near East, and for Russia, Venezuela, and the U.S.A.

Tables on pages 114, 116, and 118 give the annual production of the different countries since 1857. G. D. H.

827.* **Most Canadian Provinces Being Prospected.** Anon. *Oil Wkly*, 27.7.42, **106** (8), 94.—In Ontario the recent exploratory work has been mainly in search of gas. No new fields were found, but drilling was maintained in the Malahide field. Ontario's oil output fell. At Stony Creek, in New Brunswick, oil and gas are obtained from the Albert series (Middle and Lower Mississippian) in lenticular sandstones on the north limb of the Hillsborough syncline. In 1941 653,430,000 cu. ft. of gas and 22,334 brl. of oil were produced. A test is being drilled on the south limb of the Hillsborough syncline. Geological reconnaissance has been carried out in the Havelock–Cornhill and the Sussex–Portage Vale areas of New Brunswick.

Four deep tests are planned in Saskatchewan. G. D. H.

828.* **Rumanian Oil Situation Deteriorates.** E. A. Bell. *Oil Wkly*, 27.7.42, **106** (8), 72.—The 760,960 ft. estimated to have been drilled in Rumania during 1941 was less than the 1940 figure. The Dambovitsa and Prahova regions probably produced 35,700,000 brl. of oil in 1941, and the Buzau and Bacau areas may have given 525,000 brl.

The refining during 1941 is expected to have amounted to 33,600,000 brl., less than half of the estimated capacity.

The 1941 exports are estimated at 21,700,000 brl., a further decline. Exports by overland routes during 1941 may have been 9,217,000 brl., more than double the 1940 figure.

Tables give data on the production, refinery runs, exports, and the quantities exported by various routes in different years. G. D. H.

829.* **Shell Opens Badly Needed New Field for Colombia.** J. V. Hightower. *Oil Wkly*, 27.7.42, **106** (8), 80.—During 1941 oil was found in Casabe 1 on the Yondo concession, which now has four producers. Elsewhere in the Magdalena Valley the wildcats were disappointing. Two producers were completed in the Tres Bocas and Socuavo areas north of Petrolea.

In 1941 the Colombian oil output fell by 4% to 24,423,551 brl. 84% of the total was from the De Mares concession, and 82% of the De Mares oil was from La Cira. 3,945,654 brl. came from the Barco concession and mainly from Petrolea.

Gas was found in Cimitarra 1, and a show of heavy oil. Tres Bocas 1 found oil at a depth of over 3000 ft., and Socuavo 1 found it at about 9100 ft. South Sardinata 1 gave a little oil before being abandoned.

The rate of exploration has been maintained during 1942.

Drilling and production data are tabulated and the concession bids and changes during 1941 are listed. G. D. H.

830.* Shrinking Exports Bring Drop in Mexico's Output. Anon. *Oil Wkly*, 27.7.42, **106** (8), 76.—Fourteen oil-wells, one gas-well, and fourteen failures were completed in Mexico in 1941. The oil production was 42,885,000 brl., as compared with 43,920,000 brl. in 1940. The 1941 domestic consumption was 28,075,000 brl. 5,920,000 brl. of oil were produced on the Isthmus. Three of the 1941 producers were completed in the Tampico-Panuco area, four in the Poza Rica–Mecatepec field, and seven on the Isthmus.

15,810,000 brl. of oil were exported to U.S.A. in 1941. Gasoline consumption in Mexico increased by 14·5% last year.

Production and drilling statistics are given for 1940 and 1941. G. D. H.

831.* Venezuela Sets Crude Production Record Before War Crisis Checks Exports. J. V. Hightower. *Oil Wkly*, 27.7.42, **106** (8), 52.—226,000,000 brl. of oil were produced in Venezuela last year, 10% more than in the record year of 1939. There were production increases in both the eastern and western areas, with 73% of the oil obtained from the west. Oficina had a rise of 59% to 24,500,000 brl. There was a big increase at Jusepin, and El Roble and San Joaquin had increases of 172% and 162%, respectively. In the west all the fields except Bachaquero showed rises, Tia Juana, Concepcion, and Cumarebo being outstanding.

The Santa Rosa field commenced production in 1941. Prolific production was found in the Periquito sand in Rincon Largo 1 at 8775–8790 ft. The Leona-Tigre field was developed during 1941. In Monagas the Santa Barbara field gives oil from depths of about 4200 ft. Mulata 1 gave gas from a depth of 4100 ft., and in January 1942 a producer, Mulata 2, was completed with oil at 4590–4751 ft. Quiamare 1 obtained oil at 7300 ft. on a well-defined east–west anticline. In Central Guarico production has been found in Mercedes 2, which has upper gas-sands and a lower oil-sand. Two further wells are being drilled in this area. In Eastern Guarico oil was found at Las Ollas, 30 ml. west of Santa Ana. Anaco 1 found oil at a depth of over 8550 ft. on a dome midway between El Roble and Santa Ana.

Development has continued in the same areas during 1942. The Mulata field now has seven oil-wells and two gas-wells.

Tables give production and drilling data, and the exports in 1941. G. D. H.

832.* War Pressure Stimulates Alberta Operations. F. K. Beach. *Oil Wkly*, 27.7.42, **106** (8), 99.—In 1941 Alberta gave 98% of Canada's oil output, and the bulk of this came from Turner Valley, where the drilling amounted to 376,676 ft., compared with 296,832 ft. in 1940.

In 1941 six wells were producing from the continental Lower Cretaceous beds at a depth of 2200 ft. at Wainwright. The terrace structure of Red Coulee gives oil from the Blairmore at a depth of 2500 ft. The Lower Cretaceous is also productive at Vermilion at depths of 1850 ft., but the field is patchy. At Princess the oil is in the Palæozoic limestone at 3200 ft. 20 ml. south of Princess oil was found at Tilley, but neither area is yet of much importance.

Turner Valley has been extended to the north by large producers, and it has also been extended to the south. Water at depths of 4300–4500 ft. below sea-level limits the field to the west. Forty-one producers were completed at Turner Valley during 1941, and they had average initial productions of 722 brl./day. All the wells are acid treated. In the first ten years of the development, vapour-phase oil was the principal objective, and 11,750,000 barrels of naphtha had been obtained up to the end of 1941.

Viking and Kinsella supply gas. During 1941 about 20,000 brl. of oil were obtained from the Athabaska tar-sands.

Drilling and production data are tabulated. G. D. H.

833. Fuel Power and the Soviet State. M. Edelman. *New Statesman and Nation*, 29.8.42.—A short account is given of the Russian plan, announced in 1938 by Molotov, for the establishment of a second Baku between the Volga and the Urals, which by 1943 is to produce 6,000,000 tons of oil—about 20% of the average production of the Caucasian oilfields. Workings have been started at Syzran, on the Volga, where a refinery has been established and connected by pipe-line to the cracking plant at Ufa,

which now provides the Soviet's current reserve of aviation fuel; this being in addition to storage tanks in the Volga and Ural regions, unofficially estimated at over 6,000,000 tons.

The Ishimbayevo wells were yielding in 1938 more than six times the output of the Syzran fields, and lower-grade fuel is being produced in Kazakhstan.

This Volga–Ural–Kazakhstan region should produce over 5,000,000 tons of oil in 1942 if the Third Five-Year Plan has been fulfilled. M. G.

834.* Appalachian : Search for New Oriskany Gas Yields Few Results. Anon. *Oil Gas J.*, 30.7.42, **41** (12), 136.—In South-west Pennsylvania the Lower Devonian was tested on several structures without success, although there were oil- and gas-showings. On the Chestnut Ridge additional wells have been completed in the Onondaga and Oriskany, one of the Onondaga wells being gauged at 12,000,000 cu. ft. of gas/day. A well which entered the Helderberg found a large but rapidly declining flow of gas, probably from a fissure. Four gas-wells have been completed in the Injun and Fifty Foot sands of Fayette County, and east of Monongahela Township a good show of oil was found in the Big Dunkard, but it was cased off because of its remoteness from other oil production.

The Oriskany pool in Kanawha and Jackson Counties, West Virginia, seems practically to have been defined. Few of the wells have gauged less than 1,000,000 cu ft., and many are over 5,000,000 cu. ft.

A small oil-pool in the Big lime has been developed in the heart of the Oriskany field. A large gas-well has been drilled in the Buffalo district.

In western Lee County, Virginia, a small high-gravity producer was completed in the Trenton, and opens up for prospecting a narrow belt along the Appalachian Mountain front.

A summary is given of the completions during the first half of 1942. G. D. H.

835.* California : Discovery Rate Maintained but Added Reserves Small. L. P. Stockman. *Oil Gas J.*, 30.7.42, **41** (12), 94.—During the first half of 1942 California's crude-oil reserves were reduced by 53,000,000 brl., following on the 116,000,000 brl. reduction in 1941 in spite of the discovery of nine new fields. Although the rate of discovery has been favourable during the past eighteen months, with few exceptions the discoveries have been small. Little attention is being given now to Cretaceous possibilities which seemed to show promise several months ago.

A test in the Wheatville district of Fresno County flowed 186 brl. of 61·8 gravity distillate and 3,958,000 cu. ft. of gas/day from 8020 ft. A well is to be drilled at Yorba Linda, where oil and gas were indicated at a comparatively shallow depth in 1937.

It is estimated that about 2700 additional wells could be drilled in fields producing heavy oil.

230,700,000 brl. of oil were produced in the first six months of 1942—a greater quantity than has been produced in any six-month period since 1938.

The Bowerbank gas-field was discovered in 1942. It produces from the Pliocene Mya zone. Deeper drilling and extension work in the Elk Hills and Newhall Potrero fields have increased crude reserves in both areas. Miocene Stevens production has been proved at Elk Hills, and the Pliocene zone producing area has been extended. At Newhall Potrero, a well south of a cross-fault has proved an additional 400 acres in the Modelo.

Production statistics for the fields are given for six-month periods commencing 1939, and the completions in the first half of 1942 are tabulated. G. D. H.

836.* Canada : Exploration Blankets Wide Area in Western Provinces. V. Lauriston, *Oil Gas J.*, 30.7.42, **41** (12), 126.—Since 1920 three producing wells have been completed in the Fort Creek shales at Fort Norman. 53 ml. below Fort Norman seepages are known both on the upper Mackenzie River and near the Great Slave Lake.

In the Peace River block of northern British Columbia oil prospects are believed to be favourable, and two Alberta areas related to this block are potentially oil-bearing. To the east the Pouce Coupe structure is being tested. A large gasser was obtained, and several oil- and gas-shows have been found in later wells. The oil in the slightly tilted monocline of the Peace River field still farther east was drowned by big water-flows.

Plant capable of giving 540 brl. of oil/day is again in operation near McMurray, where the Athabaska tar-sand is the raw material.

The Priddis and Jenner structures are being tested in southern Alberta. Operations have been discontinued in the Steveville–Princess field.

A new field has been opened near Tilley. Strong oil-shows have been found in the Devonian on the Ram River structure. Cretaceous heavy oil is being pumped at Vermilion.

Turner Valley continues to be the dominant producing area, and drilling activity is the greatest in the field's history.

The well completions are tabulated. G. D. H.

837.* Clayton Pool Only Active Area in Ohio. Anon. *Oil Gas J.*, 30.7.42, **41** (12), 130.—101 oil-wells and 209 gas-wells were obtained out of a total of 469 completions in the first half of 1942, when activity was 38% below that in the same period of 1941.

A 40-acre spacing is being permitted for gas-wells in all horizons except the Onondaga, Oriskany sandstone, or Devonian shale horizons.

The proven area of the Clayton pool is now 4500 acres. A test 3 ml. south of the present pool has shown a little gas in the Clinton.

Only fair results have been obtained from Berea and shallower tests in proved fields. Tests are being made in search of stratigraphic traps on the western side of the Parkersburg syncline. The east flank of the Cambridge anticline is also being tested.

The Hinckley pool seems likely to be a major Clinton gas-pool, and one oil-well has been drilled. A 9,000,000 cu.-ft. gas discovery has been made in a Clinton sand-lens in Holmes County. In the prolific Brush Creek pool the gas completions have been below average. A gas-strike has been made in the Clinton in west central Vinton County at a depth of 2400 ft.

The well completions in the first half of 1942 are summarized. G. D. H.

838.* Drilling in the United States Falls Below Recent Levels. W. V. Howard. *Oil Gas J.*, 30.7.42, **41** (12), 76.—There were 3846 fewer completions in the first half of 1942 than in the corresponding period of 1941, and 2995 fewer oil-wells. The decline in drilling has affected nearly all areas except the eastern fields, Indiana and New Mexico. Gas development has declined notably. Much of the development drilling can be attributed to a few widely scattered new fields. Imposition of the 40-acre spacing rule has not affected normal practices in all areas. The tendency towards deeper drilling has been accelerated in the past half-year, resulting in a 10% increase in average depth.

Drilling has fallen off by 40% in Illinois as compared with the first half of 1941. The main activity in Arkansas–North Louisiana–Mississippi has been at Midway, the Pettit zone at Haynesville, and in the eastern part of the Wilcox trend surrounding La Salle parish. The results of recent drilling in Nebraska and the adjacent parts of the Forest City basin have not been encouraging. The small discoveries except in the southern part of the State are largely responsible for the 33% decline in completions in Oklahoma. A new small Woodbine fault-line field and a Paluxy discovery in the basin south of the fault have revived interest in the East Texas area. Recent discoveries in North Central Texas have been mainly small.

Lack of markets has restricted activity in South-west Texas and on the Gulf Coast, and while there are marketing difficulties in the Rocky Mountain area also, production has actually increased. Deep drilling has declined considerably in California, but the demand for heavy oil may cause many shut-down wells to be reconditioned.

A table compares by States the completions in the first half of 1941 and in the first half of 1942. G. D. H.

839.* Forest City Basin. Anon. *Oil Gas J.*, 30.7.42, **41** (12), 139.—Seventeen wells were completed in Nebraska in the first half of 1942, compared with forty-seven in the same period last year. Most of the wells were in the Dawson pool, which produces from the Hunton. A Viola test is reported to have swabbed some oil from a depth of 2922 ft., but water intruded after acid treatment. Another test in the Dawson pool showed stained Wilcox at 3230 ft., but, on testing, gave water only. The Viola and Simpson both had showings of oil.

A table gives well-completion data. G. D. H.

840.* **Illinois : Intense Prospecting Uncovers Many Small Pools.** Anon. *Oil Gas J.*, 30.7.42, **41** (12), 119.—The discovery rate of new fields in the first half of 1942 reached a higher peak than in the same period of any previous year. Total completions were nearly 50% below those for the first half of 1941. The number of oil-wells declined by 637 to 480. Oil production fell from 11,585,000 brl. in January to 8,429,500 brl. in June.

With the exception of Boulder, all the new pools are considered small. The first Boulder well was completed as a Devonian gas-well in 1941. Saturation was reported in the Benoist and Cypress, which were not tested. In April 1942 a large Benoist oil-producer was completed south of the discovery well. The new wells have not tested the Devonian.

Many new discoveries have been made in Wayne County, most of them being in a line with Dundas, Clay City, and Johnsonville. However, most of these fields are relatively unimportant, in spite of comparatively large discovery wells.

Few discoveries have been made, and there has been relatively little development this year in the Wabash River area, which yielded most of the new fields in 1941, although it has very good possibilities.

A summary is given of the well completions in the first half of 1942, and the half-yearly production is tabulated for the period commencing 1939. G. D. H.

841.* **Indiana : Small Fields Found in Posey and Other Southern Counties.** Anon. *Oil Gas J.*, 30.7.42, **41** (12), 130.—Not a single new field of major importance was discovered in the first half of 1942, in spite of widespread wildcatting. Out of a total of 207 wells only eighty were oil-producers, a considerably lower percentage of success than last year. 60% of the State's oil is obtained from the Griffin pool, which has had practically no development this year. This would have caused a marked drop in Indiana's production but for the output of Mount Vernon, discovered late in 1941.

Osage lime production has been found in the Hazleton area. New pools in Posey County were heralded by large discovery wells, but later tests either failed or gave small outputs.

Well-completion data are tabulated for the first half of 1942. G. D. H.

842.* **Kansas : Interest Directed Mainly to South Flank of Barton Arch.** C. Hoot. *Oil Gas J.*, 30.7.42, **41** (12), 91.—724 wells, including 148 wildcats, were completed in Kansas during the first half of 1942. Eighteen of the wildcats had an initial potential of 7046 brl. Cambrian production was obtained on a south-eastern extension of the Alberta–Otis structure in the Lamotte sand at a depth of 3551 ft. A few Arbuckle and Lansing–Kansas City wells were drilled in this area, but found little production.

In Reno County the new Peace Creek Viola lime trend was extended north-east and south-west, and the five pools along the trend were joined by producing wells into a single field. There has been rapid development of the Smyres pool on the eastern flank of the Central Kansas uplift. This yields oil from the Mississippian at about 3330 ft.

The Ray pool has extended Lamotte sand production into Norton County.

The production of the various fields is tabulated for half-yearly periods from the beginning of 1939, and summaries are given of the well and wildcat completions during the first half of 1942. G. D. H.

843.* **Louisiana Gulf Coast : Spacing Rules Cause of Drop in Drilling and Discoveries.** F. L. Singleton. *Oil Gas J.*, 30.7.42, **41** (12), 115.—Well completions fell markedly in the first half of 1942, due mainly to the 40-acre spacing rule, which has curtailed work around salt-domes. Activity has shifted to blanket sand fields which are generally assumed to be deep-seated salt-dome structures. Only four new fields were opened. At Ferriday gas-distillate was found in the Tuscaloosa at 8935 ft., but the well was plugged back and completed in the Wilcox at 4567 ft. Gas-distillate was found at Hayes at depths of 11,646 and 11,660 ft., and several other sands were logged. Salt at 10,005 ft. has been proved at West Bay field, which was discovered in 1940. This field yields oil mainly from Miocene sands at 6800–7400 ft. The Bay De Chene gas-field has been shown to be a salt-dome. Prolific Miocene production was found at 7470 ft. in an outpost test in the La Fourche Basin Levee district.

It seems likely that the Bayou Sale field will be joined to the Bateman Lake field.

Gas-distillate production in a new sand at 10,703 ft. was found in the extreme south of the former field. New sands were found at Delta Duck Club and Delacroix Island. New production was found on the flank of the old Leeville dome.

A summary is given of the completions in the first half of 1942, and the production of individual fields is tabulated for half-year periods from 1939 onwards. G. D. H.

844.* North Louisiana, Arkansas, Mississippi : Midway and Haynesville Keep Area in Spotlight. Anon. *Oil Gas J.*, 30.7.42, **41** (12), 140.—The discovery of Pettit production at 5500 ft. revived the declining Haynesville field, thus accounting for 75% of the North Louisiana activity.

The Midway field was opened by a 12,000–15,000-brl. well in the Smackover at −6032 ft., and a narrow north-west–south-east structure has been developed. The northern edge has been partly defined.

The east end of the Wilcox trend in La Salle and neighbouring parishes had considerable development in the first half of 1942, leading to the discovery of new fields at South Jena, Summerville, Trout Creek, and Willow Lake. The Ferriday test showed oil in the Tuscaloosa, although it was completed as a Wilcox producer.

Well-completion data for the first half of 1942 are summarized, and the production of individual fields is given for half-year periods commencing 1939. G. D. H.

845.* Michigan : Northern Sector Development Raises Production. O. C. Pressprich. *Oil Gas J.*, 30.7.42, **41** (12), 129.—Production during the first half of 1942 was 10,296,000 brl., compared with 6,849,000 brl. for the same period last year. The increase is due mainly to the development of Reed City and Headquarters, which gave over half the total oil.

The Reed City pool has been extended by nearly 1000 acres this year. Production has been found in the Monroe at Adams, and this has encouraged deeper exploration throughout the entire north-central basin area. Although no discoveries have yet been made, shows have been found. Evart seems to be the best discovery of 1942 so far. The Riverside play was short-lived.

Gas-well completions are at about the same level as in the first half of 1941.

The half-yearly production of individual fields is given from 1939, and well completions in the first half of 1942 are summarized. G. D. H.

846.* Oklahoma : Paul's Valley Find Opens Large Prospective Area. C. Hoot. *Oil Gas J.*, 30.7.42, **41** (12), 122.—The completions in Oklahoma during the first half of 1942 were almost 50% below the figures for the first half of 1941, and, due to the 40-acre spacing rule affecting the ratio of wildcats to exploitation wells, the proportion of oil-wells to total wells also fell in the first half of 1942.

On the northern flank of the Arbuckle Mountains, Wilcox production was found at a depth of 3900 ft., north-west of Paul's Valley. Favourable indications have been found east of the discovery well.

The most active areas were Hotulke and West Hotulke, which have now been united. Production is from the Viola, Hunton, and Second Wilcox. The Brooksville find has oil in the Hunton, Centerpoint oil in the Simpson, and McComb oil in the Hunton.

The Navina pool obtained oil in the Layton on the Nemaha granite ridge after finding the Wilcox dry.

The production of individual pools is given for half-year periods commencing 1939, and the completions in the first half of 1942 are summarized. G. D. H.

847.* Permian Basin, Panhandle : Major Pool Development Under Way in Andrews County. R. Ingram. *Oil Gas J.*, 30.7.42, **41** (12), 99.—A group of new pools in the south-western part of Andrews County seems likely eventually to coalesce into a single producing area. The fields involved are Embar, Mascho, and West Fuhrman, the first two being 1942 discoveries. Embar has both Permian and Ordovician oil. At Fullerton 640 acres have been proved in the Clear Fork below 7000 ft. Marketing difficulties have seriously curtailed drilling on proven acreage at Slaughter and Wasson.

Cambrian production has been found below the Ellenburger at Wentz in north-central Pecos County. Ordovician production has been found below 10,000 ft. in Eard County. A major deep field has been proved by four more 9000-ft. wells at

Barnhart. Ten other new areas or new sands were discovered in the first half of 1942, during which period the West Texas production fell by 15% because of transport difficulties.

No new producing areas were found in the Panhandle, where there are many undrilled but proven locations, and where 98% of the wells drilled gave oil or gas.

A production decline of 25% has taken place in South-east New Mexico due to reduced demand for oil there. A new producing area has been opened 7 ml. west of Tatum. About one-third of the total completions were in the Maljamar and Square Lake areas.

Well completions are summarized for northern and southern West Texas, the Panhandle and South-east New Mexico, and production data are given for each field for six-month periods since 1st January, 1939. G. D. H.

848.* Production for First Half of Year Approaches 1940 Peak. W. V. Howard. *Oil Gas J.*, 30.7.42, **41** (12), 74.—678,934,000 brl. of oil were produced in the first half of 1942, 17,491,000 brl. more than for the same period of 1941, but only 5,781,000 brl. less than in the first half of 1940. The Texas output declined by 2% in the first half of 1942, that of Oklahoma by 5%. There was a small rise in California, and also a rise in Louisiana and Kansas. Remoteness and consequent severe proration caused a 20% decline in New Mexico, whereas Mississippi attained an average daily output of 80,000 brl.

55·1% of the total oil is derived from the seventy-five largest fields. The major fields are listed, with the output in the first halves of 1940, 1941, and 1942, and cumulative production to the end of June 1942.

A table shows the trends of the major fields, and another table shows the output by States for the years 1936–41 inclusive, and for the first half of 1942. G. D. H.

849.* Reserves Added by Discoveries Do Not Balance Withdrawals. W. V. Howard. *Oil Gas J.*, 30.7.42, **41** (12), 54.—During the first half of 1942 reserves estimated at 367,870,000 brl. have been added by discoveries and extensions, and while this is 311,064,000 brl. less than the production in the same period, the deficiency is made good by the upward revision of proven reserves in older fields by 314,070,000 brl. The estimated reserves discovered are 257,836,000 brl. less than for the same period of 1941. The 1942 discoveries are less than those for 1941 in California, Texas, and the northern Mid-Continent, whereas the reverse is true in the Rocky Mountain area, New Mexico, Arkansas, and Louisiana. However, the Texas discoveries hold out promise of much greater additions in the near future.

The smallness of the amount of oil discovered is a reflection of the exceptionally small amount of development drilling, so that although numerically the discoveries and extensions are similar to those of previous years, lack of development has caused less to be added to reserves.

The first half of 1942 has opened up more new areas and new zones than any other recent half-year period. In Michigan new fields have been found on the north-west side of a belt trending north-east–south-west across the State, and in old fields there has been extensive deepening of wells to the Monroe. The Viola trend has been extended in Kansas, and oil and gas have been found in Pennsylvanian and Ordovician pays in Barber County well down the flank of the Barton Arch. Sweet oil has been found in the Smackover at Midway, opening up a large area which extends into Texas. There have been further developments in Wilcox production, and the Ellenburger production has been extended in West Texas, raising the hope that many Permian fields will also have oil in older beds.

A table gives by States the reserves on 1st January, 1942, reserves added by discoveries and extensions in the first half of 1942, and the production during the same period. G. D. H.

850.* Rocky Mountain Area : Drilling Operations Decrease; Two Deep Sands Found. T. R. Ingram. *Oil Gas J.*, 30.7.42, **41** (12), 134.—Colorado, Wyoming, and Montana had substantial decreases in completions during the first half of 1942 as compared with the same period of 1941, but North-west New Mexico showed an increase.

Four discoveries were made in Wyoming, those at Pilot Butte and Cody being deeper oil horizons, and those at South Elk Basin and Sherrard being gas-wells. At West

Kevin and Midway, Montana, small extensions were made to 1941 discoveries, but Colorado had no success with either of its two major wildcats.

Improved demands for heavy crudes led to increased production in all areas.

Development of the Hospah field in New Mexico increased drilling during the first half of 1942 as compared with the same period of 1941.

Most of the prospecting in the Rocky Mountain area, in spite of the existence of many untested structures, has been the drilling of deep tests on producing structures, many of which remain to be tested in the Tensleep and Embar, with the possibilities of the Madison and other pre-Pennsylvanian horizons in Wyoming and Colorado still practically unknown.

Well completions in the first half of 1942 are given, and tables show the production for half-year periods starting 1939, for all the areas except New Mexico. G. D. H.

851.* Eastern Texas : Black Oak May Start Paluxy Play in Middle of Basin. R. Ingram. *Oil Gas J.*, 30.7.42, **41** (12), 124.—The Concord discovery north-east of Montalba has had two dry holes, one 1500 ft. south-west of the producer, and the other 1 ml. north-west. Club Lake, a Woodbine discovery, has two further producing wells. Two dry holes drilled at Club Lake may be due to faulting. The Black Oak Paluxy production is the first in the Tyler–Woodbine basin south of the fault system.

When Smackover production was found north of the fault system at Midway in southern Arkansas, there was much leasing along a line a little north and west of the Balcones fault system.

A summary is given of the completions during the first half of 1942, and a table sets out the production of individual fields during half-year periods commencing 1939. G. D. H.

852.* North Central Texas : Ordovician and Mississippian Pays Found Over Wide Area. R. Ingram. *Oil Gas J.*, 30.7.42, **41** (12), 131.—During the first half of 1942 several Mississippian lime discoveries were made, in addition to finds in the Ellenburger and Simpson. In the Simpson oil was found east of Bowie at a depth of 7200 ft. Ellenburger production in the south-western part of K.M.A. continued to dominate development. Near Post Oak, in Jack County, Ellenburger production was found. Marble Falls production at a depth of 7173 ft. was obtained east of Forrestburg after a well had failed to find oil in the Ellenburger.

Among the wildcats there were eighty-seven dry holes and thirteen discoveries.

Production and well-completion data are tabulated, the former being for half-year periods beginning 1939 and the latter for the first half of 1942. G. D. H.

853.* South-west Texas : Discoveries Increase Despite Drop in Exploratory Drilling. F. L. Singleton. *Oil Gas J.*, 30.7.42, **41** (12), 103.—Fifteen fields were opened in South-west Texas during the past six months, when 631 wells were completed. Probably the most outstanding feature was the expansion of Wilcox development along the old Jackson shore-line trend. The first Carrizo production was opened at South Caesar at a depth of 6552 ft., with a second sand at 6611 ft. A gas-distillate producer was completed at Yorktown in the Wilcox at 7192 ft., with a second distillate producer in the Wilcox 11 ml. to the south-west and at 8300 ft. There has also been up-dip development of the Wilcox, the play having extended into part of the old Balcones fault-line district. Activity has been curtailed around the Agua Dulce–Stratton field due to the 40-acre ruling and sand irregularity. The Seeligson field has been extended to the south-west, adding several million barrels of oil to the reserves. In the east a new sand has been found. The Frio may be the producing sand in two new fields in Jim Wells County.

In the Laredo district development was largely concentrated along the Frio-Vicksburg trend. Five new pools were found, two being gas-distillate producers.

Well completions in the first half of 1942 and production data for six-month periods starting 1939 are tabulated by fields. G. D. H.

854.* Texas Gulf-Coast : Greater Penetration of Wilcox Finds Important Fields. F. L. Singleton. *Oil Gas J.*, 30.7.42, **41** (12), 111.—The Mercy structure on which Wilcox production has been found at 8273 ft. appears to be of considerable size. On

the east side of the Lake Creek field a gas-distillate producer has been completed at 11,700 ft. This is the fourth Wilcox sand to be found productive, the others being at 9200, 9700, and 10,300 ft. The top of the Wilcox is at about 8500–8600 ft.

There are now few Cockfield sand-pools along the trend in which Wilcox production has not been found.

Production from the Frio at 5300–5400 ft. has been found in three new fields—Mayo, Harmon, and West Mauritz—in Jackson County. A second sand has been opened at 5600 ft. at North La Ward. This sand appears to be a blanket sand.

None of the Wilcox areas opened recently has been fully developed, because the market cannot handle the added oil.

The production is tabulated by fields for six-month periods commencing 1939, and the well completions in the first half of 1942 are summarized. G. D. H.

855. Neutron Logs Find Porous Zones in Western Kansas Limestones. W. L. Russell and R. B. Downing. *Oil Gas J.*, 6.8.42, **41** (13), 66.—In western and central Kansas electric logs do not indicate the porous producing horizons of the limestones and dolomites with sufficient accuracy.

Neutron well-logging consists of subjecting the rocks around the well to a penetrating bombardment with artificially produced neutrons, and measuring the effect by means of an ionization chamber some distance above the neutron source. The response of the ionization chamber depends primarily on the amount of hydrogen-containing substances in the rocks—*i.e.*, on the amount of oil or water—and since these generally occupy pores, the response is often a measure of the rock porosity. However, chemically combined water in limestone or shale will also affect the ionization, thus giving misleading indications regarding porosity.

Neutron logs can be made in cased holes. If neutron logs are used in conjunction with radioactivity logs, it is possible to pick out shale horizons which give misleading porosity indications. While neutron logs at present do not show the nature of the fluid content of the pores, they do yield data about the depths, thicknesses, and continuity of the various porous rocks, which may be helpful in deciding whether oil, gas, or water is likely to be present.

The neutron and radioactivity logs of two wells are appended, and their indications are discussed. G. D. H.

856. Permian Basin Productive Area Shows Continuous Expansion. R. Ingram. *Oil Gas J.*, 6.8.42, **41** (13), 67.—The Permian Basin of West Texas and South-east New Mexico is 800 ml. long and 300 ml. wide. In the northern West Texas sector the two main geological features are the Central Basin platform, and the Midland basin which extends to the Bend Arch. Important production has been developed on the platform and in the eastern part of the basin, but during the last few years activity has been centred on the fields on the east and west edges of the platform.

The first West Texas production was found at Westbrook in the Midland basin in 1920. Not until 1925 and 1926 did development spread throughout the district, and except for the Snyder pool discovered in 1937, this accounted for most of the major development to date in the Midland basin. The Lubbock pool found in 1941 may be in the basin, or possibly on the eastern rim of the platform, if the platform turns north-east at Slaughter.

During the first half of 1942 there has been drilling at Sharon Ridge, at Welch, and in the Iatan-Denman district in addition to the Central Basin platform, where 440 wells were drilled. 313 were at Slaughter and fifty-one at Wasson. The Deep Rock–Fuhrman–West Fuhrman area has been developed into a big field. Midway between North Cowden and West Andrews production has been found in the Permian and Ellenburger at Embar, foreshadowing a link with West Andrews. In the northern district the Ordovician has been tested without success in three fields, but the Embar Ellenburger discovery is likely to increase Ordovician exploration in that district. Some believe that the Ordovician highs are much smaller than the Permian highs, and that two, three, or more Ellenburger structures may underlie the big Permian fields.

A map shows the fields of northern West Texas, and the 1942 discoveries are tabulated together with the producing fields, with information on discovery date, number of wells, production, depths, pay thickness, etc. G. D. H.

857. Trenton Strike Gives Western Illinois Area New Life. E. Sterrett. *Oil Wkly*, 3.8.42, **106** (9), 17.—Another Kimmswick lime (Trenton) pool has been opened on the edge of the Eastern Interior Basin. The discovery well, which is near St. Jacob, is 2353 ft. deep, and in an area where there have been many dry Trenton tests. Previously the Trenton had produced commercially on the western edge of the basin only along the crest of the Waterloo–Dupo anticline.

The first Trenton production in Illinois was discovered in 1910 at Westfield, on a dome on the axis of the La Salle anticline. In 1920 the first western edge production from the Trenton was found at Waterloo. Dupo, the third Trenton producer outside the Illinois basin, is also along the crest of the Waterloo anticline. Both Waterloo and Dupo had over 100 ft. of closure and 50 ft. or more of saturated reservoir rock near the top of the Kimmswick. The closure at St. Jacob is not yet known.

The St. Jacob discovery makes it desirable to re-examine the well logs and to make new tests in Monroe, St Clair, and Washington Counties east and south-east of the Waterloo–Dupo pools; in Bond, Clinton, and Fayette Counties slightly north of east from St. Jacob; and in the south-east quarter of Macoupin County.

Cores from the Dupo field show the Kimmswick to have an average porosity of 14%, and an average permeability of 7·7 millidarcys. The St. Jacob crude has a gravity of 40·9° A.P.I.

A contour map on the base of the Kinderhook–New Albany, and electrical logs of the St. Jacob well are included. G. D. H.

858. Typical Oilfield Structures: Salt-Dome; Esperson and Barbers Hill, Coastal Texas. Anon. *Oil Gas J.*, 6.8.42, **41** (13), 42.—Salt-domes occur in the coastal plain from the Mississippi to Jackson County, Texas. The formations of the plain outcrop in bands roughly parallel to the coast, and range from the Lower Cretaceous to the Pleistocene. Some beds change from continential to marine towards the coast. Although there are many sands, unconsolidated clays form the bulk of the section. The regional dip is gently coastward, with some reversals which may be due to deep-seated salt-domes. In addition there are piercement and non-piercement salt-domes. The salt may be steep-sided or overhanging. The anhydrite caps are believed to be residual, and a Jurassic age is assumed for the salt.

Oil may occur in supra-cap sands, in the cap-rock or in flank sands, the age of the producing beds ranging Pliocene to Wilcox. The producing sands are often lenticular, and the oil in the supra-cap and flanking sands may be indigenous to the pay-horizons.

Salt-domes occur also in the interior of Texas and Louisiana, and in Germany and Roumania.

The early salt-domes were found by surface features, but later the torsion balance and refraction seismograph were the chief means of discovery. Now the latter have been superseded by the gravimeter and the reflection seismograph. G. D. H.

Drilling.

859.* Procedure for Use of Drilling Lines. R. B. Southworth and H. J. Kelly, Jr. *Petrol. World*, April 1942, **39** (4), 28–31.—Determination of the length of line to be purchased depends on the height of the derrick, number of lines up, type of standby or tiedown unit, and the capacity of the draw-works drum. The total length of line in the system having been calculated, the authors suggest that a length between two and three times the length of line in the system be purchased. This may be determined by plotting the total length of line against the coat/unit wear, assuming there is one unit wear for every foot of rope moved through the system, and comparing the decrease in the cost/unit wear as the total length increases, against the probability of damage occurring to the line. As there is no way to positively determine this probability, it will have to be left to the judgement of the purchaser.

A procedure is laid down for the determination of the rate at which the line is to be moved through the system. This determination is made from a careful calculation of the work done by the rotary drilling line on similar wells already completed, coupled with a careful consideration of the total amount of work it is possible to put on a wire line of given length in this type of service.

The possibilities of this procedure are quite broad. It will give definite information

on how lines, moved in accordance with the procedure, performed, and will enable an operator to increase his rate of movement to any definite objective. Eleven curves are given. The first three deal with the determination of the most efficient length of line to purchase; the other eight are ton-mile depth-curves with points at which round trips were made spotted on them. These are average curves from various California fields. The size of drill-pipe generally used in drilling in these fields and the value of the $M + c/2$ factor used in calculating the work done by the wire line are shown on the curves. An example is worked out. A. H. N.

860.* World's Largest Power Rig in California. E. Timbs. *Petrol. World*. April 1942, **39** (4), 32.—The drilling rig described is the world's largest "power rig," or "spark-plug rig," and is being operated in California by the Superior Oil Co. It was designed and built for deep drilling, and incorporates hydraulic couplings to engage flexibly the power from each of the engines to the drive-shafts to supply the total power available for the draw-works and mud-pumps.

The rig consists of a National Type 125 Consolidated Rig, with four Waukesha engines and a National Type C–350, $7\frac{1}{2} \times 18$, and one C–250, $7\frac{1}{2} \times 15$ power-pump hooked up to two Waukesha engines, each with drive equipment mounted on the engine skids. Portable steel mud-tanks with Overstrom mud-shakers are included in this arrangement. The mud-lines to and from tanks and pumps are assembled so that the pumps may be operated either with straight discharge to drill-pipe, or compounded through the second C–350 pump when higher fluid pressures are required. Also, when greater volume of mud is required, both C–350 pumps can be operated in parallel, so that the combined fluid capacity can be discharged to the drill-pipe.

The draw-works unit is a National Type 125 which has a hoisting capacity of 680,000 lb. when using 8-line reeving and line-speeds from 270 to 3150 ft./min., plus an extra line speed of 3900 ft./min. for handling empty blocks. The Type 125, consolidated rig is rated for 12,000–13,000-ft. drilling with safety. The draw-works is described in some detail. The controls are placed for convenience.

The American Blower type of hydraulic coupling used on this rig is one in which the output speed and power are controlled by means of a scoop-tube, which by manipulation from an outside lever can be set in any position, from full dip to fully retracted. The hydraulic coupling consists fundamentally of three main elements: the impeller, the runner, and the enclosing cover, plus an outer rotating oil reservoir, a fixed manifold, and the adjustable scoop-tube. With the control of the scoop-tube from the outside, the amount of oil required to pass through the working chamber to give a determined amount of power and speed is picked up by the scoop from the outer rotating reservoir. The impeller which is formed in the cover is attached to the engine-shalf and the runner to the driven shaft. The impeller and runner are radial-vaned, but not in actual face contact with each other, and are so arranged that the impeller delivers its kinetic energy to the runner at a constant torque. The scoop, when set in any of the various positions, changes accordingly the amount of power to be delivered to the driven shaft. The control of the coupling power and speed output is particularly important when fishing, and very essential when compounding the slush-pumps.

The slush-pump unit is described in some detail. A. H. N.

861.* Casing Unloaded More Efficiently and Safely with Portable Crane. G. M. Wilson. *Oil Wkly*, 18.5.42, **105** (11), 14.—Unloading and stacking of a carload of casing in only 2 hrs., a job which formerly required at least 5 hrs., is typical of the savings being realized by a major company through use of a portable cantilever boom-crane. Unloading, and if necessary shifting of cars on the track, is accomplished by remote control from a centrally located double-drum hoist, the cable being run through a unique and efficient unloading head located beside the track to permit unloading on either side of the hoist. The crane is described and illustrated photographically. The boom is of all-welded cantilever construction, the arm or rigid section being 30 ft. long and set at an angle of approximately 45°. It was designed so that, with the crane snubbed up against one side of the railroad car, the top sheave would be slightly beyond a point directly above the opposite side of the car. Over-all clearance between the ground and the top of the sheave is $25\frac{1}{2}$ ft.

The principal members of the boom are of 3-in. tubing, and the cross-bracing sections of 2-in. Distance between the anchor or base and the boom support is 9 ft., and from there to the top sheave is 21 ft.

Of particular interest in connection with the smooth operation and control of the combined units is the specially designed unloading head. Inasmuch as the direction of travel of the cable must be turned through 90° for the cable to approach the crane parallel to the track, some type of head, preferably removable, had to be devised which would permit the cable to pass under the tracks. The unloading head is described in detail.

Numerous advantages, from the standpoint of both safety and economics, have resulted from the use of this unloading crane. Unlike a gin-pole, this crane does not require that the pipe be swung up and carried over the heads of some of the ground men, with the resulting hazards accompanying such an operation. At no point does the unloading operation require any of the men to expose himself to hazardous positions. Portability constitutes another advantage. A. H. N.

862.* Convenience and Safety Feature Portable Tool-Box Trailer. G. M. Wilson. *Oil Wkly*, 25.5.42, **105** (12), 15–16.—Considerable time and effort are being saved by the well-connection gangs and field crews of one company through use of tool-box trailers which can be towed to the job, parked in a location handy to the crew, and picked up in the evening by the truck, thus leaving the truck free to move to other parts of the field during the day.

Measuring approximately 43 × 72 in., the body of the box is of all-welded, ¼-in. steel construction. It is mounted on a pair of automobile wheels, complete with leaf-type springs. The tow-bar is a length of 3-in. pipe, amply reinforced with angle iron braces. To provide easy access to the interior of the box, the top was designed with a peaked-roof construction, with each of the two sides or covers, being hinged at the ridge-pole. Over-all height of the box itself at the peak is approximately 32 ins. and the sides are 14 ins. high. Full details are given. A. H. N.

863.* Special Arrangement of Mud Systems Necessary on Drilling Barges. G. B. Nicholson. *Oil Wkly*, 1.6.42, **105** (13), 19.—In a long paper a detailed account of the mud system used in drilling from barges is given. Principal mud-handling equipment is centralized on the middle deck. In typical barge installations, mud returns leave the casing by one flow-line, although in many cases a double line is used; and returns are transported to one side of the barge through 4-in. or 6-in. flow-line pipes and carried to the shale-shaker. Many rigs are equipped with two shale-shakers, while degassers are often used.

Fluid mud leaving the shaker drops into a settling chamber placed immediately below, while cuttings are segregated for disposal. Settling chambers are deep-bottom steel boxes about 8 ft. long, erected to remove sand and other solid particles from the mud before it is turned into the slush-pits. Mud enters the boxes at one end and flows over baffles to reach adjacent compartments. The chambers have two or three such compartments, separated by baffles, and flow through them is restricted to overflow, with the result that there is little disturbance and the period of quiescence allows sand to settle. Mud leaves the box by overflowing into the mud-ditch, which is attached to the upper section of the last compartment and receives only surface fluid from the top of the chamber.

Settling chambers are usually manipulated according to particular requirements, with baffles removable or adjusted to desired height and spacing. Trap-doors opening to the outside are provided for cleaning, with water-tight fittings to prevent leakage of mud. Accumulated sand and solids are removed through the doors. Mud-circulating systems are similarly detailed. Disposal of cuttings and transportation of mud are discussed, and special problems are analysed. A. H. N.

864.* Portable Basket Improves Moving of Derrick Parts. Anon. *Oil Wkly*, 1.6.42, **105** (13), 17.—As finally constructed, the equipment for moving a derrick consisted of three units or baskets built of reclaimed tubing and sucker rod, and collectively capable of carrying the entire structural parts of a derrick, with the exception of the (usually) unitized substructure beams and the heavy water-table, these being handled as before by means of winching to place on the truck-bed.

The basket, welded throughout, is provided with one side rigidly fixed at 90° to the base, the side being braced with diagonal crossed strips to prevent sagging under load. The opposite side, also braced for structural rigidity, is affixed to the side of the base by means of loops formed in the vertical braces, so as to allow this side to hinge about the rail and lie flat to facilitate stacking or removing of the derrick members from the basket.

This drop-side eliminates the need of lifting heavy derrick parts over the side, and possible damage through their being dropped on to material already stacked. Both sides are equipped with lifting bails, hinged to permit closure above the lead, and into which a winch-line or crane-hook may be inserted to provide a straight lift. A. H. N.

865.* Fluorescence Analysis Reaches Practical Development Stage. F. B. Taylor. *Oil Wkly*, 22.6.42, **106** (3), 27.—Analysis of drilling muds by fluorescence is described. When ultra-violet rays strike an ordinary atom and the energy of the rays are absorbed, an electron assumes a new orbit about the nucleus; the new orbit due to the additional energy being of greater diameter than the original orbit. In such circumstances an unnatural condition obtains and the atom is unstable. In regaining its stability, the excited electron leaves the orbit into which it was forced and returns to its normal orbit. This transition releases energy in the form of light. The entire process is fluorescence.

Types of lamps used are described, together with the apparatus for viewing samples. Roughly, crude oils fluoresce in accordance with their gravities. A distillate may show practically no glow, or possibly a thin blue. From here the emitted colour under the lamp grades down through blue and opalescent blues in the medium-light gravities to yellow in the medium-heavy gravities and to yellowish-brown, brown, and to a brown tinged with green in the very heavy-gravity group. In an Arkansas well a heavy-gravity dead crude was recovered that exhibited no fluorescence until cut with a solvent, when it showed a brick brown. Refinements of analytical technique are discussed. The difficulties of differentiating between crudes in the mud and oils or greases from the rig are indicated. A. H. N.

866.* Auxiliary Hydraulic Hoist Facilitates Handling of Casing and Drill-Pipe. Anon. *Oil Wkly*, 29.6.42, **106** (4), 14–16. An efficient hydraulically operated catline hoist for handling drill-pipe and casing around the derrick is used by a major company operating in West Texas. The hoist can be quickly and easily installed above the V-door in almost any type of drilling derrick with but a small amount of additional reinforcing of the girts. The simple hoist-control valve is conveniently located on the floor beside the V-door.

Outstanding advantages of this hoist include: elimination of certain hazards on the derrick floor that exist when the cathead is used for hoisting and towing services; reduction of fatigue of floor-men and drillers; increase in speed of handling drill-pipe and running casing; decrease in catline wear; and facilitation of handling of miscellaneous pieces of heavy equipment, since inactivity of the draw-works permits normal conversation between men above and beneath the floor. The patented device is described in detail. The maximum possible lift of the hoist is calculated to be about 3000 lb.

Desirable features, largely pertaining to the design and construction of the hydraulic unit, include: (1) elimination of freezing difficulties, since the cylinder is self-draining; (2) retraction of the piston is automatic, eliminating the need of external aid; (3) packing-glands are completely eliminated; (4) the hoist unit is integral with the derrick, making unnecessary extensive alterations when the derrick is skidded, and a minimum of dismantling if the derrick is torn down; (5) convenience and size of control unit are such that it may be placed at any suitable out-of-the-way point on the derrick floor, although it is advisable to place it as near as possible to the V-door; and (6) with the exception of the wire line and rope, all forces are under compression. A. H. N.

867.* Power Take-off from Truck Speeds Field Threading of Large Pipe. G. M. Wilson. *Oil Wkly*, 29.6.42, **106** (4), 34.—A saving of two-thirds in the time usually required for field threading of larger sizes of pipe is regularly being realized by the field-construction departments of a large company. Instead of having the men cut such threads

by hand, a mechanical method is used that employs a power take-off from the rear axle of the service truck. The apparatus is described.

A typical instance of the time being saved is shown in the cutting of a 4-in. pipe-thread. A 4-in. pipe-thread that formerly required up to 15 mins. time, and at least two men, is cut now in only 5 mins., and except for the handling of the heavy pipe, seldom requires more than one man to attend the machine. Not only in time saved on the actual cutting process, but some of the men usually required on the cutting jobs are now free to work on other phases of the field job. A. H. N.

868.* Portable Drilling and Servicing Units and Steel Conservation. J. Moon. *Petrol. Engr*, May 1942, **13** (8), 42.—It is estimated that approximately 90,000 tons of new steel derricks were used in 1942 and left standing over the holes of nearly 10,000 wells. The basis of the estimate is given.

Permanent derricks are used only a few times a year, the average being less than 1% of the time. The rest of the time they stand idle, and thus " tie up " thousands of dollars in steel and capital. On the basis of this idea, a portable 84-ft. telescoping derrick was designed in 1938, and was so successful in use that it was soon followed by other designs in different heights and capacities. Now, after several years, there is a wide variety of portable derricks, both for drilling and servicing. They are mounted on truck, trailer, or skids. Their adoption has led to the reduction or elimination of the permanent derrick, thus effecting a large economic saving for the oil industry. These remarks are elucidated.

Of several types of portable derricks now on the market, one of the popular types is designed for servicing wells to 11,000 ft., and has a 90-ft. two-piece telescoping derrick, mounted either on truck or trailer, which is usually built especially for the hoist and derrick installation to make a complete well-servicing or drilling machine. This complete machine includes draw-works, hoist, transportation, derrick, engine, crown block, raising mechanism, electrical equipment, and line, and in some cases a rotary-drive attachment. The machines travel with blocks strung and carrying their own guy-lines. Moving the equipment into position, raising, locking, and guying the derrick required from 30 mins. to 1 hr., a figure comparable to that required to move into a regular permanent derrick with a portable hoist and tie on to the pulling line or string the sand-line. Raising the portable derrick is done by the power supplied and built into the equipment, and requires no help from outside sources. The blocks are left permanently strung and the guy-wires remain attached.

Further to increase the usefulness of this type of equipment, it is available with a rotary-drive attachment, making it suitable for exploratory drilling, for shallow-production drilling, for medium-depth " slim-hole " drilling, for deepening, clean-out, and for following up big rotaries. These units are also used for all servicing operations in connection with the repair and maintenance of oil-wells. The rods are hung and the tubing is stacked in a manner similar to that in regular derricks. A typical example of the usefulness of these units is the experience of a drilling contractor in Texas, who in one year with one of these rigs, worked on fifty-eight wells, including sixteen clean-outs, eleven deepenings, ten rotary follow-ups, and twenty-one jobs of running tubing. Moves in excess of 100 miles and rig-up the same day were not unusual.

Other examples are given. A. H. N.

869.* Automatic Instrument Aids Mud and Well Control. J. B. Warren, Jr. *Petrol. Engr*, Annual Number, 1942, **13** (10), 76.—The importance of mud control is emphasized. Mud records are briefly described, in particular density records. Many wells get out of control while coming out of the hole. This is due either to " swabbing " or failure to keep the hole full as the pipe is withdrawn. The safest practicable method of detecting whether " swabbing " is taking place, and keeping the hole full at the same time, is to run the " fill-up " pump slowly until the hole overflows, shut the pump down, and after a short interval repeat the procedure. An experienced man on a drilling rig can then tell whether the hole is " taking " mud as it should. If the amount of mud that the hole is taking is in correct relationship to the speed with which the drill-pipe is being withdrawn, then the hole is not being swabbed and the danger of a blow-out is minimized. Simple as this operation appears, a little observation on various rigs will prove that this accepted method is not always followed. The reasons are simple : either the crews purposely let the mud-level in the hole go down so that

a "dry" string of pipe can be pulled, or the man operating the fill-up pump intends to avoid the trouble of starting and stopping the pump so often. Consequently, the pump is set to run at a speed at which it can be left to run continuously; hence it is not possible to tell with any degree of accuracy where the mud-level is, whether the mud is running over, or what proportion of the fluid is going into the hole. The importance of this should be stressed to the men, and in addition some method or check provided to assure carrying out of the proper procedure.

There is a need for more advanced practices in mud handling and greater education of the man on the rig regarding the importance of accuracy and thoroughness. From observation and study of the methods now used, the writer believes that a third of the weighting material used is wasted, that three-fourths of the blow-outs could be prevented, and that half of the various troubles could be eliminated by employing the caution and thoroughness any other business would employ when similar expenditures are involved. A. H. N.

870.* Drilling in Swamp Area of Louisiana Gulf Coast Simplified by Use of Barges. C. C. Pryor. *Petrol. Engr*, Annual Number, 1942, **13** (10), 122.—The barge described has been employed in drilling both in open water in the bays along the Gulf of Mexico and in swamp-lands. This barge is typical of the wide improvement that has been attendant on deeper drilling where heavy equipment operating under the severest of conditions is utilized. Unusual features of the barge are its large size and the compactness and accessible arrangement of equipment.

The main unit of the rig or drilling barge consists of two barges, 10 ft. deep, 145 ft. in length, and 32 ft. in width. When over the location for a well, the two barges are situated one on each side of two rows of six pilings, marking the location of the well. The barges are then joined by two transverse trusses. After being joined, the two barges are sunk to the bottom, forming a level platform of more than 10,000 sq. ft. The structural steel framework on the barges is covered with $\frac{1}{2}$-in. welded-steel plate on the sides, and $\frac{3}{8}$-in. plates on the bottom. The deck is of $\frac{1}{16}$-in. plate. Each barge is divided into six compartments, which are flooded to sink the barge on location. This compartment-type construction is typical of marine vessels, guarding against the entire barge being sunk when the plates of one compartment are ruptured. It is not generally necessary to prepare a level setting for the barge. Most locations in dredged canals, lakes, and bays are suitably near level. The weight of the barge usually displaces the silt in settling on the bottom, preparing its own level setting; however, should listing occur, lightening the proper number of compartments will level the barge-deck. Further details of the barges and of the equipment used are given. A. H. N.

871.* Mud-Analysis Logging in California Fields. W. A. Sawdon. *Petrol. Engr*, Annual Number, 1942, **13** (10), 48.—The equipment is housed in a trailer. Briefly it consists of a depth-meter that indicates the total depth of the hole and the location of the bit in relation to bottom; a pump-cycle counter and meter showing the rate at which the pump is operating in cycles/min.; a gas detector, and an ultra-violet light apparatus for oil detection. A sclerograph, operating in connection with the depth-meter, records the drilling rate, instrumental gas readings, pump-cycle counter readings, and power applied to the rotary table. Also included in the trailer is complete core-analysis equipment for determination of permeability, porosity, and residual fluids of any cores that may be taken. Electrical equipment employed is operated by 110-volt, 60-cycle alternating current, and when direct current is being used on the rig it is converted to alternating current by a motor-generator set mounted in the trailer.

During drilling the bit drills-up and disintegrates a circular core of the formation, and the gas, oil, or salt water contained in the pore spaces of this core are picked-up by the drilling fluid. By analysing continuously the fluid on its return to the surface and correlating for depth, the gas, oil, or salt content of the formation at the point drilled can be determined. Due to the salinity of the mud fluid generally used in California, accurate determinations of salt-water content of the formation are difficult to make, and it has been the practice in California to confine the logging to gas and oil determinations.

Logging and typical logs are described and analysed. Detection of oil and gas in the

mud is particularly studied. It appears from results obtained that mud-analysis logging provides reliable qualitative data on oil and gas saturation of formations drilled. As with other subsurface information, the results should be evaluated in connection with all other data obtained. A. H. N.

872.* Rate-of-Penetration Record Facilitates Drilling. W. A. Sawdon. *Petrol. Engr*, Annual Number, 1942, **13** (10), 71.—A combination record of factors in well drilling is described. The device providing the combined chart consists mainly of a weight indicator, tachometer, mud-pressure and torque gauges, and a kelly altmeter. The kelly altmeter shows the feet up on the kelly, and is connected to the recorder to give the rate-of-penetration graph. The recordings of each of the factors are made on an electrically-operated strip chart on which the five records are traced continuously while drilling. The recorder is mounted in a steel box with the indicating gauges, the recorder being placed to the right of the gauges so that it can be observed most conveniently by the driller. The assembly is installed at the driller's position.

The co-ordination of drilling operations provided by the chart for greater overall efficiency begins with the driller. The record is passed from driller to driller, the data are available for inspection of the tool-pusher and superintendent at any time, and the chart can be used by the engineer and geologist either during the drilling of the well or at a later date. Relative hardness of formations is indicated by the graphs, aiding in correlation work.

A specific example is described in detail. The applications of the combined chart are discussed. In slim-hole drilling when close control is more essential than in conventional drilling operations, the data provided by the five graphs should be valuable. When drilling wildcat wells, the records can help greatly in subsequent wells. The data can guide in selection of the bit and in determining when it should be changed. If it is known that the bit is about to enter a soft formation, a round trip may be saved. Whether in a wildcat well or not, a careful opinion of the condition of the bit when changed should be noted on the chart together with other bit data.

As the rate-of-penetration curve when evaluated with the other drilling factors indicates a change in formation, it should aid materially in correlation work. In addition to breaks and markers, it should also pick up faults. In one well where it was used a break was indicated when other records showed no indication of such a change. Action was taken on the basis of this information and, although details were not released, it is known that further data were obtained that verified the presence of the break. A. H. N.

873.* Rotary Pressure-Drilling Practice. E. V. Foran. *Petrol. Engr*, Annual Number, 1942, **13** (10), 44.—The primary object of pressure drilling is to control the circulating pressure on the bottom of the hole for the purpose of either suppressing or increasing the tendency of the well to flow. The control of such operations may often extend through a range sufficient to cope effectively with a potential high-pressure blow-out or to " drill-in alive " when making a completion in a producing horizon of subnormal pressure. It is apparent that to attain such objectives, equipment other than that conventionally used in rotary drilling will be required. A method of application suitable to local conditions must also be applied in conjunction with the particular drilling equipment used. Pressure drilling is not limited to depth, the records revealing that it has been carried out under prevailing conditions at depths from 3000 to 12,000 ft. Equipment and methods of pressure drilling are described.

Certain applications to which pressure-drilling equipment is most favourable are limited to consolidated formations. " Live-well " completions must be restricted to formations of the consolidated character, due to the fact that at times the pressure maintained on the bottom of the hole is less than the prevailing pressure within the productive formation. Any attempt to drill-in with a bottom-hole circulating pressure less than that existing in the formation in the case of an unconsolidated sand is certain to end in failure and difficulties the risks of which do not justify the attempt. In consolidated formation there should be no difficulty encountered in drilling ahead " alive " after the casing has been set and cemented. Any effort to drill-in " alive " before setting the casing would be extremely hazardous, and most likely would result in failure. While drilling " alive " through high-pressure formations, the amount of circulating water may be greatly reduced, probably in the amount of 75 brls./hr., in

which case any section of the producing zone having good permeability will produce freely and may require some back-pressure restriction at the surface. The water-and-oil or water-and-gas condensate may be readily separated on the surface through a high-pressure separator with a minimum of cut oil resulting.

Pressure drilling in wildcat wells is described. A. H. N.

874.* Application of Magnetic Method of Deflecting-Tool Orientation. B. Weiss, Jr. *Oil Gas J.*, 25.6.42, **41** (7), 92.—Earlier methods of bit control in directional drilling are briefly mentioned. An illustration gives the present method of magnetic orientation of tools in bore-holes. The inclination unit of a small-size single-shot instrument is temporarily replaced by a second compass unit. The single shot is then lowered through the drill-pipe until it rests in its proper position in a non-magnetic sub near the bottom of the drill-string. The second compass unit in the single shot comes to rest opposite two small bar magnets fixed in the walls of the non-magnetic sub. The photographic record which is made superimposes the position of the second compass unit upon the record of the regular compass card of the single-shot unit. This record establishes the true directional position of the two bar magnets in the non-magnetic sub, and the orientation can then be completed by considering the relative azimuthal position between the face of the deflecting tool and the North attracting magnet in the non-magnetic sub. This latter relationship is measured on the surface before the assembly is lowered into the hole. An example is worked out in full to illustrate the use of the tool. Details of the development of the tool are given.

It is noted that on completion of the orienting procedure it is possible to take a second or check single-shot survey to confirm the orientation of the whipstock. These check surveys were actually made for the specific purpose of determining whether or not the rotating procedure would disturb the accuracy of orientation. In every case it was found that the whipstock orientation was actually correct—in fact, the setting in every case checked as closely as it is possible to read the single-shot record. The practice of taking check surveys has been discontinued because results have shown this step to be unnecessary.

The design of this whipstock is such that the taper is on the outside or back of the whipstock, and the curved channel which guides the bit is very deep. One of the advantages claimed for this design is the prevention of any roll-off of the bit while drilling down the face of the whipstock. In order to test this feature, all the settings made by Sun have been made with zero allowance for roll-off. Results obtained have been uniformly satisfactory, and in a number of cases where drilling conditions have been ideal the results have checked exactly with the results predicted by the vector diagram calculations. A. H. N.

875.* Application of Mud-Analysis Logging in Gulf Coast Area. R. W. Wilson. *Oil Gas J.*, 25.6.42, **41** (7), 86.—Conventional methods of mud analysis in the Gulf Coast are described. In this area, determinations of the presence of salt water in formations by mud analysis have been successful where either of two conditions exist: First, where the sand is drilled at a very high rate, as is relatively shallow holes; and second, where the salt-water-bearing sand has sufficient rock pressure to cause inflow of the formation fluid into the mud-stream. In both these cases relatively large increases in the salt concentration in the mud occurs, allowing a distinct contrast to the usual small variations in the electrical resistivity of the mud which are due to the small amounts of soluble electrolytes picked up from shales and other non-reservoir rocks.

Many improvements have been made in the apparatus and methods of mud-analysis logging in recent months. In the latest equipment, mud is pumped from the well discharge through the portable laboratory where the gas-trap and sampling device for obtaining mud samples for oil determinations are located. This feature has lessened considerably the labours of the operating engineer and has contributed to more closely regulated and standardized operation of the various elements of this equipment. The automatic drilling-rate meter has been greatly improved along with the recording mechanism. The weight on the bit is now accurately recorded, and is used to aid in the interpretation of the drilling-rate log. An experimental drilling-rate meter now being tested has an automatic compensation for the weight on bit which renders the drilling-rate log more nearly proportional to the work done by the bit and a more reliable index to the formation hardness.

The benefits of continuous and accurate mud analysis are illustrated by cases from fields. Two incipient washouts in a string of drill-pipe were detected in one day in a well at West Columbia, Texas. These incipient washouts were detected by a gradual continuous increase in the rate of action of the mud-circulating pump; the pump rate being one of the functions continuously indicated and recorded by the well-logging equipment. By indicating the gradual increase in pump rate, which is not noticeable to the driller, the washout is noted before it develops to the extent of losing a portion of the drill-pipe and tools in the hole.

Detection of gas and/or oil in the mud is explained together with the advantage of carrying out such tests. A. H. N.

876.* Completion of Two-Zone Wells is Greatly Simplified. J. O. Farmer. *Oil Gas J.*, 25.6.42, **41** (7), 89.—Development of two-zone completion practice is briefly described. Use of side-door chokes is the main item of the paper. The removable type, already proved practical by the many hundred successful installations in New Mexico and California fields, has been largely adopted for this purpose. For the Texas and Louisiana completions, the device provides a simple but positive means to open or close circulating ports in the tubing string a short distance above the packer, after the packer has been set and the surface connections permanently installed. This makes it possible to establish circulation and to unload completely both areas without the hazards previously encountered. After the tubing and casing are unloaded and both zones cleaned out, the circulating ports are closed. This completely separates the two zones, and permits them to be produced independently of each other.

The circulating ports, which are in the special "landing" nipple, are closed when desired simply by running a blank side-door choke into the tubing under pressure and setting it in the landing nipple. This blanks off the circulating ports, allowing only flow from the lower zone through the tubing. The construction of the choke is such that it will seat and lock only in its landing nipple. The running and pulling of the choke are accomplished under pressure on an ordinary steel measuring-line, in much the same manner as a bottom-hole pressure-gauge is run.

During the five years that the side-door choke has been in use, more than sixty-two installations have been made. The tool, while originally designed and used for providing a means for utilizing gas from an upper zone to assist in flowing oil from a lower zone, has been used for several other purposes, including the separating of sweet and sour gas-zones, oil-zones producing different gravities of oil, and zones producing condensate from zones producing oil. Its latest application is to the bringing-in of two-zone wells, for its use permits permanently setting the packer and installing the christmas tree before starting circulation to unload the well. Its use also permits the taking of bottom-hole pressures of either of the two zones, and, in addition, provides means for kicking either zone should loading up occur. A. H. N.

877.* Greater Precautions Needed in Tests for Water Shut-off. H. W. Bell. *Oil Gas J.*, 25.6.42, **41** (7), 130.—A positive test of shut-off lends assurance that any water above the shoe will not have access to the formation below, that the casing will be able to withstand gas pressure without blowing out between the casing and the walls of the hole, and that pressure between strings may be obviated. There is always the possibility that the bit may have entered a water-sand below the shoe, in which case the shut-off may be erroneously considered defective. It is advisable to secure samples of the formation below the shoe, and not drill more than 5 ft. below.

The test for water shut-off is: After the casing-pressure test, the plug is drilled and formation is again entered with the bit. The hole is then bailed dry or to a point where the collapse safety factor is not reduced below two (2·0). The hole is then left undisturbed for about 12 hrs., and if any increase in fluid-level does not exceed the probable collection due to drainage-off of the pipe, the cementing is cleared for further drilling. If faulty conditions are disclosed, drilling should not be resumed until the deficiency is remedied. A. H. N.

878.* Mud Acid is Widely Used in Gulf Coast Wells. S. C. Morian. *Oil Gas J.*, 25.6.42, **41** (7), 111.—More than 1000 chemical treatments have been made on various types of wells on the Gulf Coast. Nearly all of these have been made on wells completed in

sands that either produced oil and gas or were used as input wells, in recycling, pressure-maintenance, and water-disposal projects.

The principal treating chemical used in Gulf Coast treating is mud acid. This material not only dissolves a large percentage of nearly all types of rotary-drilling muds, but also dissolves and disperses the clay-like, fine materials commonly found in almost all Gulf Coast producing zones. The removal of these finely divided compounds plus infiltered mud and water, and sometimes certain types of scale deposits, results in large increases in permeability and consequent increase in production from oil-wells and higher input rates or lower compressor pressures on injection wells.

The units used to inject mud acids are described. In one such unit the pump is operated from a power take-off and has a capacity of approximately 240 g.p.m. at 500 lb./sq. in., providing fluid can be supplied to the truck-pumps in those quantities by the facilities on the operator's lease. The unit will handle about 25 g.p.m. at 5000 lb./sq. in., which is an ample induction rate for tight formation requiring high pressure. The unit will handle all types of fluid, such as acid, water, oil, mud, and cement if necessary. The truck is of the six-wheel type, equipped with an extra large motor to give plenty of reserve power for pumping and difficult field conditions. The chemical tank is of the two-compartment type with bottom suction connections for the pump, which are duplicated in parallel to assure ample fluid capacity and safety for the large triplex pumps. The piping is so arranged, and complete, that only a minimum of connections are necessary in hooking up to treat a well. The unit is equipped with fire-extinguisher, first-aid kit, and fire-blanket as a measure for personal safety of the crews.

Mud acid contains acids that will react with any carbonates that may be present either in the sand or in scale deposits that may have formed on the face of the producing sand, screen openings, and perforations in casing, liners, and tubing. Mud acid will also dissolve an appreciable amount of a typical bentonitic mud. For example, 1 gal. will put ½ lb. of bentonite mud in solution. Ordinary 15%-by-weight hydrochloric acid, which is commonly used in treating wells producing oil and gas from limestones, will dissolve practically none of the bentonitic mud.

Mud acid contains inhibitors to minimize acid corrosion on iron and steel well equipment at the high temperature common to the Gulf Coast wells. Surface-tension-lowering agents are also present in the mud-acid solution, and the compounds permit easier and more uniform penetration of the producing sands by the acid and its more complete and rapid removal following the completion of the treatment. Emulsion preventers and wetting agents are always used to minimize emulsions of spent acid in oil, thus aiding in returning the well to production earlier and avoiding oil-treating operations. A. H. N.

879.* New Methods in Completion and Drilling on Gulf Coast. P. D. Torrey. *Oil Gas J.*, 25.6.42, **41** (7), 82.—The use of hydraulic transmission permits a power-driven rig to approach the smooth and generally better performance of the steam-engine-driven rig. It is, of course, well known that a steam-engine develops its greatest torque at low speed, whereas the internal-combustion engine develops maximum torque at or near its rated speed. As the revolutions/minute of the gas engine are reduced, the torque declines to almost zero at the stalling point. For this reason the draw-works of conventional power-driven rigs have had to be equipped with a multiplicity of gears, and the clutches have had to be designed to withstand heavy shock loads when the gears were engaged.

Similar to the fluid drives on automobiles, hydraulic drives for the transmission of power on drilling rigs permit the utilization of the more economical gas or diesel engine with the same desirable torque performance obtained from the use of steam-engines or electric motors. One type of hydraulic drive consists of a centrifugal pump connected to the engine, which corresponds to the generator on an electrical rig, and a turbine connected to the draw-works, which corresponds to the electric motor. The flow of fluid from the pump rotates the turbines, which, in turn, supplies the power for drilling and pulling the drill-pipe. Thus, with this type of equipment, the gas or diesel engine may run at a speed which will conform to the power output desired. With the maintenance of a constant speed of the prime mover, the speed of the turbine will depend on the load, and with a decline in turbine speed there is a greater development of torque.

In addition to advantages in power transmission, hydraulic drives on drilling rigs will eliminate the effects of shock loads and high stress from the drill-pipe to the engine, the fluid in the unit acting as a cushion. In like manner, the strain on drive-chains is dampened, resulting in smooth operation and reduction in wear of moving parts.

Advantages of automatic and other time loggings are discussed. Centrifugal desanding and reclamation of weighting materials in muds are explained. The use of desanding and concentrating equipment will help to keep the drilling fluid constantly in proper condition, thus reducing the hazards on stuck drill-pipe. At the same time, the elimination of the sand will reduce the abrasion of the pumping equipment and drill-pipe. The reclamation of weighting material, either while a well is being drilled or after it is completed, is an important item of cost reduction, particularly at remote locations where transportation costs for new mud-making materials are high.

Open-hole diameter surveys and their significance are amply detailed. The effects of slim-hole drilling on design of casing strings are discussed and the problems encountered studied. Cementing and squeezing in the area are described, as well as the requirements of good cements.

Three different methods of gravel packing are now used in Gulf Coast fields. The first, which is similar to the method used for the completion of water wells, consists of placing the gravel around the screen in open hole below the casing. The second method is to place gravel both inside and outside of a perforated liner, with screen set in the liner on the tubing before the placement of the gravel. The third method, which is the one most recently developed, is a pre-packed gravel liner which can be run in on the casing or set through the casing after it has been cemented and the plug drilled. The methods are explained in some detail.

Multiple-zone well completion and pressure method of drilling and completion are also discussed in this exhaustive paper. A. H. N.

880.* Power-Driven Rig is Specially Designed for Coastal Drilling. N. Williams. *Oil Gas J.*, 25.6.42, **41** (7), 84.—Development of power-driven rigs having greater flexibility in transmission and capable of absorbing the heavy shock loads of deep drilling is leading to more general use of such equipment in wildcat operations on the Gulf Coast. Steam power, which still cannot be equalled in smoothness and performance, continues to be favoured in fields and areas where fuel and boiler-water are readily available at relatively low cost, but many wildcat tests on the coast, particularly those in South Louisiana, are located in remote, isolated swamp or marsh regions. Here fuel and water must be hauled long distances. Because of the excessive costs which are often associated with transportation of fuel and water for boilers, the use of power-rigs, requiring relatively little fuel and negligible water, is considered desirable in the circumstances. The use of power-rigs is especially to be desired at this time, as they usually require only one barge, eliminating the need of one for boilers. To counteract the disadvantages of the torque characteristics of the internal-combustion engines, electric generators and motors are incorporated in the power system of the rigs.

Indicative of the development and use of direct-powered mechanical rigs on the Gulf Coast is the large, new direct-diesel power assembly which one company now has in South Louisiana. This rig, which has just completed its first hole, drilled to below 11,000 ft., embodies some of the latest improvements in direct-power and deep-drilling equipment. Some of the features had not previously been employed on the Gulf Coast and only very recently elsewhere.

The rig, specially designed for operations where drilling conditions require the use of 4½-in. drill-pipe to a depth of 12,500 ft., is powered by three 6-cylinder (8¼-in. bore × 10½-in. stroke), full diesel engines, each developing 300 h.p. at 900 r.p.m. They operate through a chain-drive compounding unit in which the power of any one or two engines or their combined power may be used for hoisting, or for driving the rotary and slush-pump at their required speed while drilling. The rig is described in detail. A. H. N.

881.* Salt-Water Evaporator System Reduces Boiler Operation Cost. W. A. Shellshear. *Oil Gas J.*, 25.6.42, **41** (7), 118.—A method of converting the salt water around the rig into pure water will eliminate barging costs, as well as give all the advantages of having the best steaming conditions in the boilers. With these things in mind an

evaporator system for distilling sea-water has been designed and installed by Gulf Refining Co., on one of its boiler barges in South Louisiana.

The evaporator system which was designed for the first installation consists of the following equipment: (1) Two submerged-coil vertical evaporators, each with 294 sq. ft. of heating surface. (2) One two-pass surface condenser with 262 sq. ft. of cooling surface. (3) One 1000-g.p.m. centrifugal pump driven by a steam turbine for condenser cooling water. (4) One flash-tank. (5) One 10 × 4½ × 10-in. reciprocating feed-pump. (6) Two steam-traps. (7) Regulator valves, pump-governor, and inter-connecting pipe and fittings. These are described in detail.

The system is arranged so that the evaporators may be opened in series or singly when one of them is shut down for cleaning. Steam is taken from the line to the rig, and its pressure reduced to 130 lb./sq. in. and run through the coils of the first evaporator. It gives up its heat of vaporization in the coils, and causes the salt water surrounding the coils to boil. The quantity of steam passing through the coils is regulated by a trap connected to the lower header, which will only allow water formed by the steam condensing in the coils to pass through to the flash-tank. The boiling salt water surrounding the coil forms steam, which passes into the coils of the second evaporator, where the same process occurs, the steam condensing in the coils giving up its heat to salt water surrounding them, which produces more steam. The steam from the second evaporator then goes to the condenser, where it gives up its heat to the circulating water and is itself condensed to distilled water. A system of this type is known as a double-effect evaporating system, and will yield approximately 17 lb. of distilled water/lb. of steam furnished to the coils of the first evaporator.

Costs are given. A. H. N.

882.* Triplex Pump Marked Advance in Gulf Coast Drilling. H. F. Simons. *Oil Gas J.*, 25.6.42, **41** (7), 88. The principal obstacle to the successful and economical drilling to depths of 12,000 ft. and beyond on the Gulf Coast, has been the lack of sufficient fluid capacity on the pumps used on the rotary rigs. A step in the solution of this problem has been the recent introduction of triplex steam-pumps for pumping the mud-laden fluid in and out of Gulf Coast wells. One practical effect of supplying more fluid capacity is a reduction in the amount of mud treatment required on many wells. As the burden which the fluid can carry is dependent on the velocity, the specific gravity, and viscosity, it was formerly the practice to increase the latter two values as the drilling progressed. Part of the effect of increasing the viscosity was lost, due to the fact that the pressure required to move the fluid through the pipe was also raised. With sufficient fluid capacity available, the engineers can concentrate on the water loss and filter characteristics and maintain much lower viscosity in the mud. The specific gravity will need to be maintained in cases where there is any danger of blow-outs, and the viscosity will need to be kept as low as possible in such cases. There have been wells which failed to reach the projected depth because of the impossibility of obtaining all of the above factors—volume, viscosity, and weight.

Other, and possibly more important effects of using a triplex pump, are the increase in the rate of penetration and the increase in the footage/bit which will result from a greater fluid capacity and lowered viscosity and specific gravity. The jetting action effect is briefly explained.

As developed for oil-field service, the triplex steam slush-pump is not merely a conventional duplex mud-pump with an additional set of cylinders. By using cast steel for the fluid end and semi-steel for the steam end, and by designing for overall compactness with due allowance for convenience, ample strength has been obtained without excessive weight. The steam-valve mechanism developed for this application by the pump manufacturer makes it possible to operate with a shorter cushion in the steam cylinders than is required for duplex pumps having conventional valve-gear. This not only reduces steam consumption in relation to output, but also results in minimum overall length. The new triplex steam slush-pump (size 18 × 7 × 20 ins.) weighs 31,500 lb., and can be moved on the highways without any dismantling and without the necessity of obtaining a special permit. Overall length, including skids, is 12 ft. 7 ins.; width is 7 ft. 10½ ins., and height, including air-chamber, is 8 ft. 8¾ ins.

Typical pump data are given. A. H. N.

883.* Torque Converters Applied to Drilling and Servicing Rigs. T. P. Sanders. *Oil Gas J.*, 2.7.42, **41** (8), 25.—In the first applications of the torque converter to drilling

rigs, the draw-works drives were designed so that the torque converter was to serve as an hydraulic transmission. Save for a high and low speed on the hoist-drum, all speed adjustment was accomplished at the converter. While these applications were successful according to all standards, a fault existed in the fact that the torque converter, acting over such wide speed and load ranges, was called on much of the time to operate at unfavourable points on its efficiency curve. By providing four speeds forward, the new rig makes it possible for the converter to act under speed and load conditions falling within the flat portion of its efficiency curve where average efficiency ranges from 75 to 85%. An example of hoisting by converters and by ordinary gearing is discussed.

In pulling a heavy string of drill-pipe the driller is ordinarily called on to be an expert judge of loads, so that he can shift draw-works speeds at the proper times. If he shifts too soon he may have to return to the lower speed, thereby consuming additional time. The torque converter serves to adjust when a higher speed is used too soon, making it unnecessary to return to the lower speed, while at the same time guarding the engines against the overload.

In addition to the feature of using torque converters with a four-speed transmission, the new rig introduces another innovation in torque-converter application. Ordinarily, when two or more internal-combustion engines are compounded it is extremely difficult to synchronize the machines so that each will carry its share of the load at all times. Small differences in the timing, the extent of wear, the condition of the intake and exhaust passages, or small cyclic variations will cause two engines to oppose one another to some degree. The use of a torque converter on each engine of the new rig serves to give the same general performance that would be obtained by compounding two electric motors. The converters are mounted on what would normally be the clutch housings of the two engines, and the output shafts of the converters are compounded, each shaft being provided with a friction clutch. In the past it has been generally supposed that it would be impractical to drive the slush-pump through torque converters. Analysis of the factors involved led to a new appraisal of this possibility. A. H. N.

884.* Automatic Recording of Mud Weight Prevents Many Drilling Difficulties. Anon. *Oil Gas J.*, 9.7.42, **41** (9), 37.—Density is one of the most important properties of drilling mud, and should be carefully controlled. If it is too great in upper formations, a serious loss of circulation may result, or excessive wall-cake may be formed, which may cause drill-collars to stick and interfere with the running of casing. At great depth, in many wells, it appears to be necessary to use mud of relatively high density to prevent small but serious incursions of gas, light petroleum, or salt water each time the bit is pulled up from the bottom. Control of mud density requires very close attention, because of the irregularities introduced by scraping walls when making trips, by adding water without measurement, by adding weighting material at a varying rate, and many other causes.

Disadvantages of the ordinary method of checking mud weight at regular intervals are discussed, and the use of automatic and continuous recording instruments is advocated. One instrument of this type receives a uniform sample from the flow line every 2 mins., and records the weight on a 24-hr. circular chart. The principle of operation is the registration of the gas or air pressure required to overcome the hydrostatic head of a given column of mud, on a chart calibrated directly in lb./gal. This machine is simple in principle, and does not depend on any delicate balance for its operation. It is entirely automatic, and differences in weights of 0·1 lb./gal. or less can easily be read on the chart record.

One typical record is presented, and, to illustrate the many things that can be recorded and observed, the following study is given: Leading up to this chart, the record for the preceding day had shown a variety of mud conditions. The testing of the casing with water pressure had been completed and the bit had been run to the top of the plug. Drilling of cement was begun with water circulation, and the dirty returns varied from 8·9 to 8·4 lb./gal. When all but 5 ft. of the cement was drilled, circulation was changed from water to 10·6 lb./gal. mud. This came back at 3 : 05 p.m. The last of the plug was then drilled out and the bit was run several joints below the casing into the open hole, bringing back cement mud and also some gassy mud from the old hole. Adding baryte was begun at 6.30 p.m., and the gain in density

showed in the returns at 8 p.m., and increased continually until a streak came back at 10.20 p.m. showing the mixing in of light mud that was gunned up in the adjoining pit some time after starting the addition of baryte. The density finally showed higher than the desired 13 lb./gal., whereupon some mud was pumped out to the reserve pit, where it sunk to the bottom, and some of the light mud from the reserve pit was allowed to flow off the top into the circulation pits. This procedure was repeated several times.

Then on the chart presented is shown the gradual equalization of heavier mud with lighter mud, until orders were received to cut the density back to 12·0 lb./gal., to permit the nitroglycerin shot to sink in the hole. Only the mud in the small suction pit and in the well was then diluted with water; which was started at 2.45 p.m. After all the mud in the system was equalized at 13·0 lb./gal., the crew started out of the hole with the drill-pipe at 9.20 p.m. At 1.45 a.m. the drill-pipe had been pulled from the hole. Notations on the chart show the other operations performed, until the chart was again changed at noon. A. H. N.

885.* Drill-Pipe Inspection as Basis for Improving Drilling Technique. T. P. Sanders. *Oil Gas J.*, 11.6.42, **41** (5), 33.—As originally conceived, the internal inspection of drill-pipe provided a systematic method for eliminating defective drill-pipe joints before they could cause fishing jobs or loss of the hole through failure in service. Careful study of a great number of strings, however, made it possible to recognize all types of abnormal drill-pipe deterioration. Correlation of this accumulated information with certain direct field observations of drilling conditions and technique led to the ability to define quite accurately the cause or causes of any disruptive condition found in the pipe.

The ingenious form of periscope used for internal inspection of drill-pipe and other tubular goods makes use of a series of lenses. Carried at the end of the instrument is a 250-watt, 150-volt mercury-vapour lamp for lighting the pipe interior. The observer can view two distinctly different types of image, depending on his manipulation of the instrument. The "annular" image, used for locating defects, takes in 6 or 7 in. of the pipe interior, and this is viewed under a magnification of 1·5. For studying individual defects in order to determine their magnitude or their cause, an angle mirror is brought into use. This makes it possible to obtain a 90° view directly into the pit or other defect under a magnification of 2.

Thorough cleansing of the pipe interior is, of course, necessary before a successful visual analysis can be undertaken. Power-driven steel brushes provide a rapid and thorough means of accomplishing this cleaning. All equipment needed for cleaning, inspecting, and spraying the pipe interiors is carried in a service truck. Generating equipment that furnishes electricity for lighting the mercury-vapour lamp also supplies power for driving the cleaning brushes. The compressor that supplies compressed air to blow away the scale and rust as it is removed by the steel brushes is also utilized to operate the spray-gun. Drill-pipe can be cleaned and inspected at the rate of 1000–1500 ft./day. A. H. N.

886.* B. of M. Reports on Particle-Size Distribution in Drilling Fluids. Anon. *Oil Gas J.*, 23.7.42, **41** (11), 42.—An abstract of the Bureau of Mines Report, R.I. 3645, is presented together with three graphs and the main conclusions. A. H. N.

887.* Gamma-Ray Well-Logging in Trinidad. G. M. Conklin. *J. Inst. Petrol.*, July 1942, **28** (223), 141–145.—A general report on gamma-ray well-logging as practised in Trinidad is given. A. H. N.

888. Patents on Drilling. F. J. Hinderliter. U.S.P. 2,284,869, 2.6.42. Appl. 27.2.40. Blow-out preventer.

J. H. Adkison. U.S.P. 2,284,969, 2.6.42. Appl. 17.4.40. Method of completing wells drilled into a stratum to be tested for production.

B. S. Minor. U.S.P. 2,284,983, 2.6.42. Appl. 9.6.39. Casing-head construction for wells.

J. B. Ferguson. U.S.P. 2,285,024, 2.6.42. Appl. 11.8.39. Sample-taking-apparatus for side-wall sampling in a well-bore.

G. D. Patterson. U.S.P. 2,285,302, 2.6.42. Appl. 18.12.39. Process for cementing wells and using an inert liquid with the cement in order to make it more fluid without increasing its porosity.

P. B. Nichols. U.S.P. 2,287,819, 30.6.42. Appl. 21.5.38. Devise for recording drilling operations.

B. W. Sewell. U.S.P. 2,287,909, 30.6.42. Appl. 10.2.40. Expansion chamber for pressure core-barrels.

T. A. Creighton. U.S.P. 2,288,124, 30.6.42. Appl. 13.11.39. Drilling-string protector for rotary well apparatus.

L. G. Howell. U.S.P. 2,288,278, 30.6.42. Appl. 23.6.41. Gamma-ray well-logging using a Geiger–Muller counter. A. H. N.

Production.

889.* Cleaning Liner Slots by Means of Explosives. J. H. Collins. *World Petrol*, May 1942, **39** (5), 29–30.—The paper describes a new explosive charge, used in the shape of a rope, which is lowered into slotted casing and fired to clean the slots. It creates high-pressure wave, sufficient to clear the slots, but with energy content to low to injure the casing. It is compared to high-voltage, low-amperage shock circuit. The inventer is Ford Alexander, who is now using it extensively.

The rope is shipped by ordinary express, with no restrictions, and is no more dangerous than dynamite fuse. In the past year the inventor's organization has used 200,000 ft.—nearly 40 miles—of it with no mishap, nor any damage to anybody's oil-well. A 15,000-ft. well could be shot from top to bottom. Neither the weight of the column of material in such a hole, nor the temperature, would affect the rope at the bottom, and no damage could possibly be done, although the velocity of the explosive is over 23,000 ft./sec. A. H. N.

890.* Chemical Reconditioning of Old Wells. J. H. Adkison. *Petrol. Engr*, May 1942, **13** (8), 156.—Field use of the acid jet-gun has proved it to be of even greater value as an auxiliary tool for increasing the efficiency of chemical treatments of oil-wells than laboratory tests initially indicated. Although it was designed primarily as an acidizing tool, its application has been broadened, so that it is now used as a means of selective re-acidizing, removing cement and mud-sheaths, removing acid-soluble cement retainers and cement plugs, cleaning out limestone cavings, and for minor deepening jobs. It has also been used in the removal of gyp and paraffin formations when ordinary circulation of acid has proved ineffective.

Application of the jet-gun in operations in which acid is not the fluid medium includes certain types of formation-cleaner treatments where paraffin solvent, butane, gasoline, kerosine or low-surface-tension water may be used as a fluid agent.

After various studies the following conclusions are recorded: (1) Various types of jet-guns may be used advantageously in the chemical treatment of oil, gas or input wells for: (i) Aiding in the selective acidizing of a formation. (ii) Cement or mud-sheath removal. (iii) Magnesium-alloy retainer removal. (iv) Drilling-out cement plug. (v) Deepening jobs of small magnitude in limestone. (vi) Removal of gyp deposits. (vii) Removal of paraffin deposits.

(2) The action of the jet stream will be affected by: (i) Design of the jetting nozzle. (ii) Acid concentration for cement or limestone. (iii) Chemical solubility of material being removed. (iv) Physical characteristics of material being removed. (v) Differential pressure maintained. (vi) The distance of the jets from material being removed. (vii) The length of time jetted up to the critical point, when distance from the jet prevents further removal. (viii) Size of the jets being used.

(3) Having the required differential pressure across the jets, the action is not affected by the hydrostatic column of fluid in the casing, as acid may be considered as incompressible, and therefore the viscosity of the fluid is unchanged.

(4) The jet-gun has definite limitations in regard to its maximum action and its effect on the permeability of a formation and the production increases that may reasonably be expected.

(5) The jet-gun will thoroughly prepare the formation of a well for a subsequent

squeeze acidizing treatment, thereby increasing the efficiency in most acid treatments. To the well-informed operator, this auxiliary treating tool is well worth the additional preparatory work necessary for its successful application. A. H. N.

891.* Engineering Study Determines Advisability of Pressure-Maintenance Installation. J. D. Collett, Jr. *Petrol. Engr*, May 1942, **13** (8), 62.—Studies of the North Novice field, Texas, are given. The producing sand in North Novice is relatively tight, of low permeability, and irregular, and most of the wells have been shot in order to obtain potentials high enough to satisfy normal operating requirements. Immediately south-west of the field is the elder Novice field, which produces from the same sand and under pressure maintenance. The success of this operation indicated that North Novice field might also benefit from return of gas to the reservoir. Novice production, which had been declining rapidly, has remained quite constant since operations were placed on a gas-return basis.

Well tests are described in some detail. It was determined that with a uniform drainage pattern it should be possible to control the gas returned to the reservoir by careful studies of bottom-hole pressures and gas–oil ratios. All wells were therefore tested for gas–oil ratios and producing rates. While this testing was in progress, bottom-hole pressures were again run on each of the wells during the potential test, to establish the productivity index of most of the wells in the field.

These data were desirable for two purposes: First, it was necessary to know that the wells were capable of producing sufficient oil to meet allowables assigned and yet have bottom-hole pressures that were high enough to prevent too much gas from coming out of solution. It was also necessary to know what effect increased allowables would have on those wells that would be affected by reallocation of allowables from wells used for injection. The second factor was the need of index data, in order to determine the pressures that would be required to inject the gas being produced by all the wells under normal producing rates. The well index-data were then used to calculate, for the wells chosen for injection, the pressure required to inject all the gas produced in the area affected by the well. This can be done either graphically with straight-line curves or by direct calculation.

The principles governing the selection of injection wells are detailed, and the plant is described.

No trouble developed during testing, and injection was begun immediately. At first very small volumes of gas were introduced into the well tubing of the injection wells, and the calculations of injection pressures checked extremely well. Rates of injection were slowly increased over a 90-day period approximately until full load was reached, at which time all calculations for pressures and capacities were checked, and found to be closer than had been expected.

Only a few minor troubles have developed to date. Regulation of the conventional separator vent-valves had to be made, and they caused some trouble. The tendency of separators to overload and force oil into the gathering line and fill the field scrubbers, thus shutting down the plant, had to be corrected. Regulating field production to allowables and constant plant-load had been the greatest problem. No trouble has occurred with the key wells. A. H. N.

892.* Locating Cased-Off Productive Zones. W. A. Sawdon. *Petrol. Engr*, May 1942, **13** (8), 55.—Radioactivity logging provides a means of logging through casing by running a highly sensitive detector into the well on a conductor cable to measure the gamma rays that enter the hole from the contiguous formation. These rays, originating in the formation, pass through the casing and cement or other material occupying the annulus between the casing and the wall of the hole, and thus identify, by means of their relative measurements, the character of the formations behind the casing. The intensity of the rays is naturally decreased by the steel of the casing and by surrounding cement or other matter. It has been found that this dampening effect of the steel is approximately four times that of the mass usually found between the casing and the wall of the hole. This resistance, however, remains a fixed constant in each particular well during logging operations, and does not affect the number of rays emanating from the formation. Radioactivity measurements have been taken through as many as five strings of cemented casing, and there are clear indications on the record when the instrument passes from or into the shoe of a string, depending on whether the run is

being made down or up. A certain amount of explanation about the theory of radioactivity logging is given.

As is the case with similar subsurface records, the interpretation of the radioactivity log is of vital importance. In fields where electrical logs have been taken in nearby wells that have been drilled recently, the general stratigraphical data supplied by the electrical log will facilitate the interpretation of the radioactivity log of an old well. When the radioactive log is taken in a well for which an electrical log is available, a comparison of the two logs assists in making a close determination of the limits of the prospective zone. In most of the fields of California the shales are decidedly more highly radioactive than the sands, and the decrease in radioactivity, shown by the trace on the chart, clearly indicates the sand-bed. In a few areas in the San Joaquin Valley the radioactivity of certain formations does not appear to conform to the conventional, and logs taken in those areas are more difficult to interpret.

Application of such logging is studied. In the Long Beach field there are two cased-off zones known to be productive in certain areas and wet in others. A portion of another zone that is cased-off in some wells is also known to carry clean oil. In other areas portions of still another zone can be profitably produced if located accurately. Most of the wells in which these zones are cased-off are old holes that were drilled with undue speed in order to reach the main producing zone. No attention was paid to maintaining vertical hole at the time the wells were drilled, and very few surveys have been made to determine their actual course below the surface. Sharp dips and numerous faults add to the difficulty of locating the prospective zones lying behind one or more strings of casing.

The radioactivity log has been used to advantage in this field to locate zones behind as many as four strings of casing. The log has sometimes been taken to determine the limits of a specific zone and at other times to provide a complete correlation of the entire well. In fields of this kind where numerous radioactivity logs have been taken and many electrical logs are available from adjacent wells recently drilled, the interpretation of radioactivity logs run in cased holes is comparatively simple. A. H. N.

893.* Packer Tester Reduces Workover Time and Labour. Anon. *Petrol. Engr*, May 1942, **13** (8), 60.—A packer tester is described and illustrated. A swage and nipple were welded to one end of a piece of 5-in. O.D. casing long enough to cover the packer rubber. Below the packer rubber a connection was welded to the section of casing. To test a packer, the equipment is inserted in the casing section, heavy clamps tightened on the swage nipple, and a second nipple on the upper end of the packer. Tightening the clamp applies sufficient pressure to set the packer. After the packer has been set, pressure from a pump may be applied through the connection welded below the packer rubber. Pressures as high as 3000 lb. have been used in testing packers.

As a result of testing packers before running in the well, savings in workover time and labour have been effected. A. H. N.

894.* Petroleum Engineering. Part 5. L. C. Uren. *Petrol. Engr*, May 1942, **13** (8), 31–34.—Further studies of American facilities for training petroleum engineers are given in this part of the paper. A. H. N.

895.* Production and Disposal of Salt Water in the East Texas Oilfield. B. W. Payne. *Oil Wkly*, 18.5.42, **105** (11), 21. *Paper Presented before American Petroleum Institute.*—In a comprehensive paper various aspects of the problem of water production and disposal in East Texas are treated from historical, technical, and economical viewpoints. This field is a water-drive field. It was inevitable, therefore, that in East Texas, as in other fields of this type, large volumes of salt water would be produced together with the oil long before final depletion of the reservoir. Until recently it had been less well appreciated, except by engineers and technologists, that since salt water under pressure constitutes the driving-force that moves the oil from the sand to the well-bore, it is of paramount importance that the water pressure in the reservoir be conserved and utilized in such a way as to yield the greatest ultimate recovery of oil. The problem of pressure and production relationship is analysed. Methods of plugging back water failed and other methods had to be found. It was first thought that the water could be evaporated in open pits in the field, but the idea was soon discarded

when it was learnt that the rate of evaporation in East Texas was practically equivalent to the rate of rainfall. Various methods of disposing of salt water were considered, including: (1) Evaporation in open pits. (2) Evaporation by aid of artificial heat. (3) Continuous of discharge of salt water into streams. (4) Storage of salt water and controlled discharge during periods of heavy rainfall. (5) Transportation of salt water to the Gulf by pipe-line. (6) Injection of salt water to subsurface formations.

Each of the above possibilities was explored. Early in 1936 the feasibility of returning salt water to the Woodbine sand was demonstrated in a test well about 2½ miles west of the field in the south end. At that time less than 50,000 brls. of salt water/day were being produced, but it was realized that the problem was one of increasing importance. Through experimentation, the return of salt water to the Woodbine sand was determined to be the most practical.

Not only has the return of salt water to the Woodbine sand been demonstrated to be the most practical method of disposal, but it also contributes materially to the maintenance of the reservoir pressure. This pressure maintenance arises from the fact that when a barrel of produced water is returned to the sand it offsets the withdrawal of a barrel of water and cancels its effect on the pressure decline. Thus, if all the produced water were injected, the effect would be about the same as if there had been no water production. It has been estimated that the reservoir pressure would now be in the neighbourhood of 1200 lb./sq. in. instead of 1000 lb../sq. in. if there had been no water production or if all the produced water had been returned to the Woodbine sand.

It is now widely accepted by engineers and technologists that water-drive is the most efficient mechanism for the production of oil, whereas production by gas-drive resulting from release of gas from solution at low pressure is the most inefficient mechanism. The relative differences in recovery between these two possible methods of production may vary in excess of 100%. It becomes apparent, therefore, that in order to obtain the maximum possible amount of oil from the East Texas field it is extremely important that the operations of the water-drive be maintained until the field is exhausted.

The growth of the practice and the engineering and economical aspects of water injection are then analysed. A. H. N.

896.* Gas-Drive Prolongs Producing Field Fifteen Years. G. B. Nicholson. *Oil Wkly*, 25.5.42, **105** (12), 17.—The system employs thirty injection wells, located at strategic sites in the field. The key wells are changed as conditions in the reservoir vary, with the purpose of receiving the highest recovery/cu. ft. of gas injected, in addition to flooding new areas previously untouched. Input pressures vary from 15 to 250 lb., with wells located near the edges of the structure requiring more pressure, due to proximity with the water-level. At each key well is placed a regulator to adjust pressures applied, with three types used, as follows: (1) manual controller, (2) differential controller, (3) volumetric controller, each type offering specific advantages to cope with conditions met in wells.

Gas with pressure reduced to the desired amount is turned directly into the casing of the key well served by the regulator. Input wells use no tubing, being equipped with 6-in. casing and having light fittings at the casing-head and swages to facilitate connecting gas-line. A gate-valve is also provided on the line to allow shutting off gas supply when desired. In the lower section of the hole is set a 4½-in. slotted line, allowing injected gas to escape from the casing and penetrate the formation.

Producing wells are provided with the usual type pumping equipment, consisting mostly of older-type 25-horse-power units, although two central powers operate several wells. The majority of pumps are placed close to bottom, but local conditions in many wells require variation in subsurface installations, to overcome the tendency of wells to gas lock, or to avoid troubles from soft sand, which is sometimes prevalent. As a rule, sand troubles are slight, excepting after injection pressures and procedures are altered, or when location of input wells is changed. Other details of the system are given.

The company operating the system, by carefully manipulating position of key wells and by skilful application of conservation methods, economically and profitably operates the field, having established the gas-drive unitization at the opportune time to save the life of the producing area. Based on estimates from present rate of production decline, engineers figure that parts of the field will produce economically for

another five years, with probability of producing 2,000,000–3,000,000 brls. during that period. A. H. N.

897.* Unsteady Flow of Vaporizing Hydrocarbons Through Unconsolidated Sand. Part 2. T. Y. Ju and R. L. Huntington. *Oil Wkly*, 25.5.42, **105** (12), 28.—Experimental data are presented in tabulated and graphical forms and are discussed in this, the second part of the paper. Correlation of experimental with calculated values of cumulative production *versus* time check well. The equation is

$$Q = \beta T^{\gamma}$$

where Q = cumulative production in time T; β and γ = constants.

Rate of vaporization of propane in the pipe and the rate of production from the pipe are not the same. Calculations are presented. For butane runs, the vapour pressure is so low that the rate of production and the rate of vaporization are practically the same. A. H. N.

898.* Systematic Removal Essential to Paraffin Control. G. M. Wilson. *Oil Wkly*, 1.6.42, **105** (13), 27.—Through efficient use of tubing scraping, steaming, and combinations of such controls that have been developed by service companies, together with some developments of control instigated by certain larger operators, the paraffin problem has been reduced mainly to a matter of properly scheduling the working-over of affected wells.

Scraping devices have probably become most widely used. One service company, operating out of several bases located in both West Texas and New Mexico, has a fleet of small truck units specially equipped for scraping and cleaning out the string of tubing in a flowing well—for example, in as little as 2 hrs. total elapsed time from setting up the equipment to tearing down and leaving the location. Longer periods are required, of course, in wells in which particularly large amounts of paraffin have been permitted to accumulate and which have not been cleaned out for some time.

The 3-ft. scraping tool or knife is lowered into the tubing on a piano-wire line. A combination sinker bar and short-stroke jar are used in conjunction with the knife, similar to the way in which the drill-stem and jars are used in a cable-tool outfit. Scraping is discussed in some detail. Reversed circulation and steam may be used to help in scraping. A. H. N.

899.* Unsteady Flow of Vaporizing Hydrocarbons Through Unconsolidated Sand. Part 3. T. Y. Ju and R. L. Huntington. *Oil Wkly*, 1.6.42, **105** (13), 32.—Further experimental data are presented. From the results of the investigation presented here, the following conclusions may be reached for a butane or propane reservoir: (1) The vaporization of butane or propane in unconsolidated sand is more or less isothermal, due to the large heat capacity of the sand body. (2) Due to the presence of sand, the pressure change in liquid phase cannot keep pace with the removal of the liquid by vaporization. Consequently there exists a pressure gradient between different heights in the liquid section of the reservoir, over and above the hydrostatic head. (3) The curve for production-rate decline of reservoirs of this type is similar to that for reservoir depletion of the usual type. The only difference is the absence of the sharp initial drop in the case of the reservoir used in this investigation. (4) The cumulative production quantity is complicated with many variables, such as rate of production temperature of reservoir, nature of hydrocarbons, etc., yet it may be expressed as a simple relation by

$$Q_p = \beta T^{\gamma}$$

(5) The rate of vaporization of the liquid declines in the same manner as the rate of production. (6) The rate of production can be expressed by a modification of Pierce and Rawlins' formula for gas-wells:

$$\frac{\Delta Q_p}{\Delta T} = C\left[\frac{P^2 - P_s^2)}{(Q_0 + Q_s)}\right]^n$$

Q_0 is zero if the reservoir has no gas-cap, and Q_s is practically the same as Q_p, especially for butane. Therefore, from the pressure-decline data it is quite possible to estimate the future production rate by means of this equation within the accuracy generally required for practical application. A. H. N.

900.* Development, Operation, and Valuation of Oil and Gas Properties. Part 2. P. J. Jones. *Oil Gas J.*, 4.6.42, **41** (4), 53–54.—This part of the paper deals with the flow of homogeneous fluid through linear porous media. The flow of liquids and gases is treated mathematically and illustrated with examples. Cases of constant and variable permeabilities are studied. A. H. N.

901.* Application of Back-Pressure Tests to Gathering Systems. J. W. Ferguson and M. F. Shaffer. *Oil Gas J.*, 4.6.42, **41** (4), 39–42.—The Authors develop a graphical method of solving the problems of well deliveries in a gas system against a given range of pressures. A layout of a gathering system, with a considerable spread in rock pressures, is assumed, and the problem is solved as an illustration of the method. A composite curve with irregular kinks is the result. If the rock pressures were all within a narrow range, any kinks in the composite curve would fall close together, at pipe-line pressures close to the rock pressures of the wells. In this event it is not necessary, or even particularly desirable, to calculate a great many points for plotting the final curves. Only enough points should be calculated to define the final composite curve.

It is noted that if it is desired to limit the amount of gas produced from each well to a percentage of its open flow, or by any other arbitrary procedure, the process for obtaining the composite curve would be identical, except that the quantities from a given well would increase with decreasing line pressures until the allowable is reached; from there on, the allowable would be used instead of the actual producing ability of the well. This condition would, of course, pre-suppose the necessity for manual or other control of each well to limit its production to the allowable quantity. A. H. N.

902.* Record System Aids Repressuring Efficiency. G. M. Wilson. *Oil Wkly*, 15.6.42, **106** (2), 16–19.—A system of recording the activities of one property is described in detail. The property is divided into three general, roughly defined areas—the north-west, north-east, and the south-east. For production-record purposes, each of these areas is further broken down into subdivisions, making thirty subdivisions for the repressured area. Distances and certain royalty matters are factors governing the formation of the smaller subdivisions. Each of these subdivisions is made up of from five to fifteen wells which produce into an individual trap, header, and tank battery, where gas and oil produced are accurately gauged and recorded.

A card-filing system is kept in which a complete "case record" is noted for each individual well. Each well has a card on which is tabulated the depth, casing, and tubing data, and a chronological record of all changes of pump locations, or significant changes in the well's performance. Special note is made of instances where a well is changed from producing over to an input well, or vice versa. Each month, following tabulation in columnar form of all the production and injection data, the figures are transferred to the curve-sheets. The values in each curve in most cases are plotted against time, the latter being in monthly units.

The following items are recorded: (1) Average daily oil production at each battery. (2) Average daily oil production for each of the three general areas. (3) Average daily production for entire repressured area. (4) Gas produced daily on each subdivision. (5) Average gas–oil ratios for the month for each subdivision. (6) Average gas–oil ratios for the month for each of three general areas. (7) Average gas–oil ratios for the month for entire repressured area. (8) Daily oil rate *versus* cumulative production of entire repressured area. (9) Rock pressure of each injection well. (10) Multi-curve sheet containing five quick-reference curves. (11) Multi-curve sheet containing five quick-reference curves. This is similar to (10), but is compiled as an average for the entire repressured area. (12) Gas returned to each of the injection wells. (13) Gas returned to each of the three general areas. (14). Total gas returned to entire repressured area. (15) Extraneous gas injected. (16) Gas volume treated at gasoline plant. (17) Gasoline produced at plant for entire field. (18) Gallons of gasoline/1000 ft. of gas. (19) Decline curve of repressured area. (20) Decline curve for each of the three general areas.

Each of these items is briefly described. A. H. N.

903.* Controlled Water Injection Sustains Reservoir Energy. G. B. Nicholson. *Oil Wkly*, 22.6.42, **106** (3), 17–19.—Plymouth Oil Company, by controlled injection of

water into one of several producing sands in the Plymouth field of San Patricio County, South Texas, maintains constant bottom-hole pressure and calculates sustaining a driving-force which will be of economical benefit in receiving greatest ultimate recovery from the reservoir. Volumetric withdrawals are replaced systematically by forcing salt water into the bottom of the sand section, with an additional amount injected to assure minimum pressure fluctuation.

Injection water is obtained from wells in the field producing from other formations; and careful chemical and mechanical treatment is given it to remove undesirable elements which seal the face of receiving sand or add to the corrosion of equipment, assuring highest operating efficiency. Salt water produced from sand at 5800 ft. is used for injection, being obtained from gun-barrels of three tank batteries serving wells producing from that formation. With injection of all water produced by these wells, flooding provides a dual purpose, as salt-water disposal is also effected, with construction of evaporating pits or other disposal facilities unnecessary. By staggering delivery of water from batteries to the injection system, loads on delivery lines are kept low, permitting use of the simplest, most effective, and least expensive gathering system.

Water, after being drained from the tank batteries, is stored temporarily in an open pit. When each battery feeds its water into the injection system, a centrifugal pump located near the pit at the battery is placed in operation, lifting water from the pit and forcing it into the delivery system to reach the injection plant. Automatic controls, regulated by hard rubber floats on each pump, stop pump action when fluid level is lowered near bottom.

Details of the pumping of water are given. No wells on the lease produce water, and all flow naturally. Gas is still being injected into one well located high on the structure, an average of 350,000 cu. ft. daily being forced into the single key well. Gas injection was started in October 1938, and has been continued without cessation in attempting to maintain constant bottom-hole pressure. A. H. N.

904.* Efficient Equipment Lowers Gas-Lift Costs. Anon. *Oil Wkly*, 22.6.42, **106** (3), 38.—By making certain changes in the equipment employed in the operation of a gas-lift project to obtain oil from wells ranging around 6000 ft. in depth, a major producer has been able to reduce the quantity of gas 76½% of the amount formerly used to lift even a smaller number of barrels of fluid. The type of gas-lift installed at the start of the programme was the conventional type, which required an ascertained depth of submergence and at various times a high gas-pressure to kick them off.

One well in particular, while producing on the old-style gas-lift, required an average of 1,067,000 cu. ft. daily to lift 128 brls. of fluid, but when changed to the newer type required only 250,000 cu. ft. to raise 136 brls., the sum total of which, when multiplied by several wells of this character, amounts to a substantial saving of operating horse-power, lower lifting costs, and a reduction on depreciation of equipment.

Details of the improvements are given. A. H. N.

905.* Development, Operation, and Valuation of Oil and Gas Properties. Part 5. P. J. Jones. *Oil Gas J.*, 25.6.42, **41** (7), 197–198.—In this part of the paper formulæ and graphs are given for the flow of oil-water mixtures through media of uniform permeability. From the discussion it is deduced that, aside from surface and gravitational forces, the ultimate recovery from oil reservoirs available to natural and artificial water-drives is limited by (*a*) non-uniform distribution of specific permeability, (*b*) a physical upper limit of available or induced pressures, and (*c*) an economic upper limit of water–oil ratios. Specific permeability ratios can be controlled, within limits, by selective completion methods. On the other hand, pressure may be controlled, within limits, by selective location of wells for primary production purposes and by spacing wells for artificial water-drive purposes. A. H. N.

906.* Hydraulic Pumping is Applied to Deep Wells on Gulf Coast. C. E. Buchner, Jr. *Oil Gas J.*, 25.6.42, **41** (7), 136.—Development of hydraulic pumping in deep wells both in California and Gulf Coast is briefly reviewed. The principal factors to be considered in the Gulf Coast area are: (1) depth; (2) free gas; (3) sand; (4) paraffin. The hydraulic pumping system has certain innate characteristics that are easily adapted to any or all of these conditions.

Due to the high efficiency obtained from hydraulic transmission of power, depth is no factor in adapting this means of pumping to Gulf Coast wells. Besides this advantage the hydraulic system offers in wells of all depth the maximum amount of horse-power available to the subsurface unit with a minimum amount of weight. This is especially economical in deeper wells where the ratio of horse-power to weight becomes quite great with the older mechanical methods of pumping. A 12-h.p. hydraulic-power unit punmping a 7700-ft. well is illustrated. The hydraulic system further ensures greater safety in tubing setting depths, as any movement of the tubing due to pumping pulsation is eliminated. Furthermore, the elimination of any moving mechanical parts within the tubing prevents wear on the tubing, which is especially important in crooked holes as sometimes encountered in the deeper wells. Free gas, sand, and paraffin effects are discussed.

Multiple well pumping with the hydraulic system offers several savings in critical materials so vital to the Government as this time. Due to the low ratio of horse-power to weight, savings of from 30% to 85% in steel may be effected over the conventional method of pumping an oil-well. The largest savings are, of course, on multiple-well installations, frequently making it possible to pump seven wells with the same amount of steel previously required to pump one well. Centralizing of controls at the tank battery also affords a saving in rubber. The pumper has to visit the tank battery to gauge the tanks periodically, and there he can check the operation of each well without visiting the individual well-heads. Any adjustments necessary to specific wells can be made at the manifold. Bottom-hole pressures, pumping-fluid levels, and other important factors can be quickly determined, providing a constant knowledge of down-hole pumping conditions.

In conclusion it is stated that the hydraulic pumping system has been considered for pumping 15,000-ft. and deeper wells. Equipment has been designed to lift as much as 500 brls./day from such depths. It is within the realm of this method of pumping to lift larger quantities from this depth or deeper, if the occasion demands. Sizes are now available in capacities up to 4500 brls./day and depths to 15,000 ft.

A. H. N.

907.* Operation of Gulf Coast Field is Aided by Gas-Cycling Programme. F. L. Singleton. *Oil Gas J.*, 25.6.42, **41** (7), 113.—As a result of a pressure-maintenance and recycling programme, three main objectives are being achieved in one field: (1) The installation has made possible operation of wells that were shut in because they could not be produced without wasting some of the reservoir gas essential to the maximum ultimate recovery of the oil. (2) Reservoir pressure is being maintained while oil is being produced, thus making possible efficient recovery of the oil existing in the reservoir through widely spaced producing wells. (3) Production is being made available by the use of far less quantity of steel and other materials than would be required to develop an equal production by drilling of addition wells. The field is described together with the plant used.

The pressure-maintenance and recycling programme was designed to serve the entire productive area, and was made possible by a unitization plan agreed to by most of the operators and lease-owners in the field. The unitized block consists of about 2000 acres, and the pooling agreement is of special interest in view of the fact that it not only covers gas and condensate, but also crude-oil production. Such an agreement has not been made, so far as is known, in any other pooling agreements on areas serving pressure-maintenance or recycling plants.

The plant was designed to process and return to the formation approximately 25,000,000 cu. ft. of gas daily. The installation is one in which oil and condensate are recovered separately by dual installation of the separators and tank batteries. The dry gases from both separator batteries go into a common header through a final separator scrubber to the inlet of the compressors, where it is boosted to the required pressure to return to distillate formation.

A. H. N.

908.* Production Curtailment Makes Paraffin Problem More Difficult. P. D. Torrey. *Oil Gas J.*, 25.6.42, **41** (7), 143.—In a long paper paraffin scraping and removal by other means are discussed in some detail. The paraffin, when it first comes out of solution, is in the form of minute wax crystals. These fine particles tend to coalesce into larger fragments, and are carried along in suspension until they find a favourable point for

accumulation, which is generally at places where some physical change affects the carrying power of the oil. These places may be at points of slight irregularity in the tubing and at the tubing collars, at gas-lift valves where the expansion of gas has a cooling effect, and at points where the fluid level varies from time to time by intermittent production, resulting in a periodic recoating of the pipe-wall with a film of oil. In high gas–oil ratio wells, where the oil comes from the well as a mist or froth, the recurrent coating of the tubing wall with oil, at a point where the temperature is sufficiently low to precipitate the paraffin from solution, will almost invariably result in the formation of a deposit. The reduction of high gas–oil ratios by some form of remedial work is one preventive measure for the elimination of paraffin accumulations. Although all these various factors affect the deposition of paraffin to varying degrees, probably the chief source of the increased trouble in flowing wells that has been experienced in recent years in Gulf Coast fields is due to restricted production. When the wells are shut in or are produced at a very slow rate, there is a greater loss in heat to the surrounding formations, resulting in a lowering of the temperature of the oil, to the point where paraffin will come out of the solution. Also, since the velocity of flow is greatly reduced, the carrying capacity of the oil is diminished, so that the fragments of paraffin tend to accumulate rather than to be flushed out.

Several types of scrapers are described. Heat and chemical treatments are also discussed. Probably the best method for preventing the formation of paraffin deposits over the sand-face or perforated liner is to maintain always the oil-fluid level above the top of the sand. Exposure of the sand-face permits the evaporation of the lighter liquid fractions, which results in the precipitation of the paraffin, and is accompanied by a reduction in oil production. Removal of paraffin accumulations from the sand-face and from liners may be accomplished by the use of hot water, steam, high-test gasoline, heat-generating chemicals, or chemical solvents and softeners. The use of various chemicals combined with vigorous swabbing has produced satisfactory results in some of the older Gulf Coast fields. A. H. N.

909.* Radioactivity Logging Proves Help in Reworking Old Wells. Anon. *Oil Gas J.*, 25.6.42, **41** (7), 140–142.—It is emphasized that radioactive logging does not provide information regarding the content of porous formations, nor does the amplitude of radioactive intensity of various formations enable the operator to reach any reliable conclusion concerning the porosity and permeability of the formations, such as may be gained from a study of the self potential curve of electrical logs, other than the general fact that sandstones are usually more porous and permeable than shales. Therefore, the development of new production, by the use of radioacitve surveys, from older wells must be based either on a knowledge of the productive possibilities of a particular horizon obtained from the record of other wells, or on a series of tests designed to provide this information. In the latter case, a radioactive log will show the position of the more promising horizons, and thus prevent shooting of bullets into and testing of shale sections.

Radioactive surveys may be made in open hole or through casing. They have been made in larger number in cased holes, where it is impossible to make electrical surveys. As shown in a table, the relative radioactivity of various sedimentary rocks varies to the extent that a measurement of the amount of radioactivity provides an excellent criterion of the formation. Thus, by measuring progressively the radioactivity of the formations encountered in a well, it is possible to predict their lithology.

The amount of radioactive material in a particular bed or formation may remain fairly constant over a wide area, so it is possible to distinguish various horizons from the radioactive logs by the amplitude of the intensity curve, and thus use the logs for the purpose of correlation where other records are not available. The difference in radioactive content of different beds gives a fairly definite change in amplitude of the recorded curve at contacts, and therefore permits these points to be established with a degree of accuracy comparable to that obtained from the use of electrical logs.

Characteristics of the three types of radiation and the mechanism by which they are detected and amplified are briefly discussed. A study is made of typical radioactive logs before and after squeeze-cementing a well. A. H. N.

910.* Tubing Perforators to Solve Special Gas-Lift Problems. G. G. Kingelin. *Oil Gas J.*, 25.6.42, **41** (7), 120.—The purpose of the tubing perforator is to provide a

simple and a positive means to perforate tubing mechanically under pressure with the use of an ordinary steel measuring line, jars, and stem. This perforator is a wedge-and-knife tool that is easily lubricated into the hole under pressure, set at any depth, and any number of holes can be made with one trip of the tools. It consists of an adjustable stop, a wedge, a knife, and knife-base. A hole is punched through the tubing simply by driving a tapered wedge against the back of the knife. The angle of the face of the wedge is small enough to enable the conventional tubing jars and stem to impart a blow sufficient to drive the cutter through the tubing.

When the perforator is suspended, the weight of the knife and knife-base holds the cutter in a retracted position and facilitates the running and pulling of the tool. In order to expand the cutter, a stop is first set in the tubing to act as a rest for the perforating tube, to permit the wedge to be driven against the knife. The rigging up necessary in order to run the tubing perforator is approximately the same as that required for running and pulling any other subsurface tool that is run through a lubricator. Three applications of the tool are described in some detail to illustrate the benefits of perforating in the well for gas-lift purposes and thus obviate the necessity of pulling out the tubings. A. H. N.

911.* Reservoir Pressure Maintained by Regulated Gas Injection. G. B. Nicholson. *Oil Wkly*, 29.6.42, **106** (4), 24.—Regulated gas injection into the Heep sand, one of several producing formations in the Plymouth oilfield, has terminated a previous steady drop in reservoir pressure, kept rate of production decline level, and maintained satisfactory flowing conditions in virtually all wells producing from that horizon. Of a total of eighty-four Heep-sand wells on the large Welder lease, all flow with the exception of two which are on gas-lift, these being located in a sand-lens not directly related to the main body, and accordingly not completely affected by repressuring. As result of gas injection, the affected formation now has the same capacity for producing as it had when discovered.

By maintenance of constant reservoir pressure, the bulk of dissolved gas has been held in solution, keeping underground oil less viscous, and hence easier to move through the sand-pores, as well as maintaining driving energy within the fluid. By proper rate of flow combined with gas injection, energy has been utilized as a driving and lifting force rather than dissipated in either the reservoir or tubing.

Controlled and scientifically engineered injection into the Heep sand has maintained the existing gas-cap in its original state, and holds the pressure of the water drive constant. Water influx admitted in proper volume exerts the force necessary for obtaining greatest recovery, and full efficiency of the water-drive is being obtained. Company engineers estimate that recovery from this formation will be increased up to 60% over expected recovery without repressuring. Among other benefits from repressuring are: (1) utilization of maximum natural reservoir energy and gas in solution; (2) water encroachment from edges has been controlled, and coning in producing wells rectified, with less volume of water produced to-day than when injection started; (3) net cost of production is less than if wells were worked over; (4) additional oil is now recoverable without expenditure of steel and vital war materials.

A. H. N.

912.* Arkansas Oil and Gas Industry Managed on Engineering Basis. A. M. Crowell. *Petrol. Engr*, Annual Number, 1942, **13** (10), 55.—The State's conservation statute is described and the benefits derived from its application are explained. The work is praised. A. H. N.

913.* Determining Productivity Index of Pumping Well by Copper-Tubing Method. Anon. *Petrol. Engr*, Annual Number, 1942, **13** (10), 115.—Productivity index is defined and the formula for obtaining it from pressure build-up is derived. The determination of the productivity index of a pumping well by the copper-tubing method consists of the following steps: (1) determination of build-up characteristics of well by measuring rate of fluid-level rise in the casing after pump is stopped; (2) fluid-gradient determination by copper-tubing method. (This requires that the fluid level remain constant while two separate measurements at different depths are made); (3) substitution of values for h_1 and h_2 in the integral formula for corresponding values of t_1 and t_2. Values for the four variables are scaled from the h *versus* t build-up curve.

In many instances in production engineering work it is convenient to determine

productivity indices when wells will not flow—that is, when the bottom-hole static pressure is not sufficient to raise fluid to the surface. This is particularly important in newly completed wells in areas of semi-wildcat character. Many times such wells test as potential producers, but will not flow with continued swabbing.

There then arise the questions whether (1) the well is merely slow in attaining a flowing state due to a low permeability of the sand, (2) the drilling fluid has penetrated the formation clogging the pores, or (3) the productivity index is very low and the well must be placed on the pump immediately. As the well cannot be made to flow naturally, a productivity index is not attainable by the ordinary methods. In such a case the method of determining productivity index by means of measuring rate of rise of fluid in the well over a period of time may be used. A. H. N.

914.* Gravel-Packing Wells to Increase Production Efficiency. L. C. Uren. *Petrol. Engr*, Annual Number, 1942, **13** (10), 81.—A comprehensive review of gravel-packing is appended by a good bibliography on the subject. Many advantages are visualized for the well equipped with a gravel-packed liner, all of which tend to increase its production efficiency. When properly placed in the annular space between the wall of the well and the perforated liner, gravel supports the walls of the well, preventing caving of formations against the liner, and serves to restrain sand from unconsolidated and disintegrating strata, so that it may not enter the well. More effective screening of sand, possible by this means, diminishes the destructive influence of sand-scouring on well equipment, tending to reduce maintenance costs. Equipment repairs and well clean-out operations are less frequent and the well is able to produce for a greater part of the time than would otherwise be the case. The well so protected is therefore capable of maintaining a larger monthly production rate.

Using gravel to sustain the walls of the well, it is possible to form and maintain a well of larger diameter through the producing formations, without elsewhere increasing the normal diameter of the well or that of the well-casing. This larger-diameter hole through the producing zone results in increased current rate of production and ultimate production of the well. Ability thus to increase the production efficiency of wells results in increase in the percentage recovery of drainable oil; or, for a given percentage recovery, may permit wider spacing of wells and result in reducing development and operating costs on oil-producing properties.

The development of gravel-packing is given. The principles of gravel-screening, size of gravel, bridging, thickness of the envelopes, and their porosities and permeabilities are each discussed separately. The three types of gravel-packs are described in some detail and are compared with each other. Economics of gravel-packing are further discussed. There are cost data and oil-recovery records obtained from operations in several California fields that demonstrate important economic advantages for wells packed with gravel, by the reversed-circulation method. Additional costs of gravel-packing, in comparison with the cost of conventional completion methods, range from \$1050 to \$3250/well, varying with the depth and thickness of the producing formation to be gravelled and the diameter of the well and liner. The higher figure is for wells in the Wilmington field, California, where the average thickness of the zone gravelled is 400 ft., 5½-in. liners are used and wells are wall-scraped to about 16 in. A large part of the cost is represented by the cost of rig time, which is included in the figures quoted at the rate of \$350/day. In the case of the Wilmington field, the cost of five days' rig time, or \$1750, is included. The material and equipment cost does not exceed \$1500 in any case. Gravel can be purchased in this locality for \$6/ton. Savings are discussed. A. H. N.

915.* Gravel Pre-Packed Liners. F. A. Graser. *Petrol. Engr*, Annual Number, 1942, **13** (10), 36.—A review of the development of gravel-packing is presented. Eighteen years ago the relationship of the size of sand-grains that could be screened by a slot was established, whereby it was determined that sand-grains would not pass through a slot if the diameter of the grain was greater than one-half the width of the slot. At the same time it was found that if there was a mixture of different sand-grains with one-seventh of a larger size, then this larger-size sand would form a bridge over the slot-opening and screen out the finer sand. Later work along this line in a separate investigation developed the fact that this percentage could be as small as one-tenth of

the volume in order to screen effectively the balance of the sand. Later development resulted in pre-packed gravel liners.

Pre-packed liners have the following advantages over conventional pack: (1) very short and very long liners can be landed in proper position; (2) the pre-packed liner is adaptable to multi-zone production and to the use of combination strings; (3) the gravel is held in position by a retaining sheath, so that all portions of the pack are of uniform thickness; (4) the cost of under-reaming in stages and subsequent water loss are diminished; (5) bottom water can be more easily plugged-off, due to the fact that well-shooting is practicable and that the casing is nearer the size of the under-reamed hole.

There have been two principal objections raised against the pre-packed liner: (1) that the retaining sheath acts as an outer casing and that a casing inside of a casing tends to seal-off and prevent the maximum amount of oil from entering the well; (2) that lignitic materials and waxes will be left in the gravel and gradually seal-off the oil. The first of these objections has been obviated by using large gravel.

Methods of cleaning these packs are described. Not all the mud is removed from the well with the present methods, as was shown by the fact that very little water is lost to the formation after the filter-cake is removed. Further work may be done in this direction, and it is probable that an acid or a de-flocculating agent may be spotted back of the liner as a final operation before closing the ports of the hanger.

There are no records of liners becoming frozen off bottom because of the removal of the filter-cake. In fact, the opposite is generally the case, and the liners are picked up more freely after washing. Operators space their well-cleaning guides 20–30 ft. apart as a rule, and then remove the liner that distance to pass "scratchers."

In the past it has been necessary to use opposing swab rubbers and a washing tool for wells in which a part of the liner was cemented-off or in which a combination string was used. Some of the operators are so confident of the advantages of the abrasive action in use with washing liners that considerable effort is being made to devise means of washing and "scratching" wells under these increasingly difficult conditions. If a method is in sufficient demand, the oil operator or engineer will devise the means, and the prediction can be made that this is a step to be expected in the near future.

A. H. N.

916.* Oil Reservoir Drainage Increased by Intermittent Air-Injection. F. R. Cozzens. *Petrol. Engr*, Annual Number, 1942, **13** (10), 120.—When a large volume of air is forced into porous sections of sand for a number of hours, and the pressure released for a like period of time, the air gradually filters or "bleeds" back into the more permeable channels, bringing with it oil and water containing considerable residue. This residue, commonly known as "floating sand," soon settles out, and on examination is found to be made up of cement-like material that forms the natural binder of the sand itself. When the air pressure is again applied, this fluid, minus most of its residue, is forced back into the so-called dormant pockets of the sand, returning again during the "off" interval with more residue. The action is similar to that in the violent jetting of water against a surface rock, which eventually becomes honeycombed and porous by the force and intermittent action. In a sand such honeycombing continues in several directions, and when the binder in the sand in the immediate area of an oil pocket or reservoir is removed by erosion, the accumulation of oil is released into more permeable channels, and thus recovered. In practically every locality where intermittent air-drive is practised, this action manifests itself by sudden increases in oil production in certain wells that may amount to several times the normal output. The volume of production increase and its duration depend on the size of the reservoir that has been drained. In this manner, oil pockets and reservoirs in various parts of any producing formation may be tapped.

Details are given for Eastern U.S. fields.

A. H. N.

917.* The Stripper-Well Problem. J. F. Weiler. *Petrol. Engr*, Annual Number, 1942, **13** (10), 162.—A discussion of stripper wells in the U.S.A. is presented. Of the producing wells of the country, 75% are stripper wells that comprise 18% of the reserves. Of the total abandonments, practically all are stripper or marginal wells, and a decreased price and overproduction in 1931 accentuated an excess abandonment of 62% over drilling, but abandonments because of depressed prices are greatly overstated. Many stripper wells are profitable. The marginal-business argument is not applicable,

because a natural resource is being depleted. The marginal-well cost, however, could be eliminated under an optimum-rate limitation for production. These wells could be shut-in for the duration of the low-price period, and most could be produced again unless water problems were present, and by more efficient secondary recovery methods the total recovery would be considerably greater and more economic.

In Texas the marginal-well law should be revised, taking into consideration all economic factors, not just depth, so that the wells can be pro-rated on an optimum-limitation schedule. In the future the importance of the stripper-well argument will decline under optimum-rate control of flush fields, for the properly produced oil-pool will leave a less persistent legacy of stripper wells, thus rendering the unrecovered reserve in the stripper stage of less relative importance than it is to-day. Therein lies the key to the stripper-well problem.

The present Government policy is indicated in a publication in *The Petroleum Engineer*, March 1942, in which a sub-committee of the Petroleum War Council appointed by Petroleum Co-ordinator Ickes studied ways and means of increasing oil reserves and preventing abandonments of marginal wells. The sub-committee found that a depletion allowance enabled the industry to continue exploration activities, and thus find new reserves, and enabled operators of marginal wells to keep on producing, and thereby maintain the continuity of their output for war purposes. References are given at the end of the paper. A. H. N.

918.* Submersible Magnetic Strain-Gauge. E. H. Lamberger and B. F. Langer. *Petrol. Engr*, Annual Number, 1942, **13** (10), 64.—As the magnetic strain-gauge is the basic element of the submersible gauge, a brief description of its construction, principle of operation, and characteristics will be of interest. The magnetic strain-gauge may be defined as a device that transforms small displacements into readings on an electrical instrument. It has a wide variety of applications, and many quantities, such as stress, force, torque, and acceleration, can be measured by means of the displacements that they produce. In the submersible gauge an axial displacement is measured. The gauge is illustrated and described.

Under the most favourable conditions one of the gauges illustrated can give full-scale deflection on an indicating instrument, or 4-in. deflection on the film of a magnetic oscillograph for about 0·0003-in. gauge motion. The maximum sensitivity when used with a graphic meter is full scale for 0·001-in. motion. These valves are based on a gauge with a maximum motion of 0·010 in. and a power supply of 115 volts, 800 cycles. Under these conditions the gauge requires about 15 volt-amp. at a low power factor. The sensitivity is directly proportional to the impressed voltage and inversely proportional to the total air-gap. The air-gap mechanically limits the maximum motion. A lower power-supply frequency necessitiates a lower voltage in order to keep the gauge from overheating. The calibration can be adjusted to the desired value by varying the voltage or adjusting the calibration resistor.

The complete gauges were thoroughly tested under pressure in the laboratory during development. During one test a gauge was under pressure for more than 2 weeks, with maximum pressures of 2500 lb./sq. in. They were tested in tension at loads as great as 20,000 lb. The calibration was practically linear over the entire range of load. The combined characteristics of the gauge, its control, and the recording oscillograph were such that load variations with a frequency up to 18,000 cycles/min. could be measured with a maximum error of 10%.

One of the gauges used in actual service in oil-well pumping tests was placed in the sucker-rodstring just above the pump plunger at a depth of 3500 ft. The second gauge was placed in the string approximately 1750 ft. down the hole. These gauges were in the field for 6 months, were lowered into the well three times, and were in operation in the well for a total period of more than 4 weeks. They had been sealed before leaving the factory, and were returned to the factory at the end of the tests with original seals unbroken. Calibrations at the end of the pumping tests checked original calibrations. A. H. N.

919.* Multiple-Zone Completions of Oil- and Gas-Wells. E. O. Bennett. *Petrol. Engr*, July 1942, **13** (11), 19–20.—A brief discussion of multiple-zone completion problems is presented. The following are stated to be advantages of multiple-zone completion practices: (1) Steel requirements are reduced by half when the zones are closely

spaced. (2) Drilling costs are cut in half, as one well is used to produce the allowable normally produced by two. (3) The method provides the maximum number of injection locations in pressure-maintenance operations. (4) Approximately 50% reduction in the cost of pumping equipment when contemporaneous pumping is carried out for two zones. (5) Saving of time in drilling a new field when conditions suitable for multiple-zone completions exist. (6) Provides increased availability of steel for exploratory development now that a shortage of steel exists. (7) Reduction in the cost of well-head equipment/zone. A. H. N.

920.* **New Removable-type Circulating Valve.** J. O. Farmer. *Petrol. Engr*, July 1942, **13** (11), 35–36.—The purpose of this new tool is to provide a means to open circulation ports above a packer by pumping into the tubing, to close these ports when the pumps are shut down, positively to prevent interzone communication at all times, and to alleviate the task of moving the tubing or pulling the side-door choke to produce the same result. The valve is described together with its mode of installation and its action. Although this tool is quite new, results from its use have been most satisfactory and encouraging. All installations have been made at approximately 10,000 ft. and under the most adverse conditions of temperature, pressure, and mud. The advantages realized from the new tool are summarized as follows: (1) Under no condition are the two zones of a dual completion produced simultaneously. (2) Accumulated head in either or both tubing and casing may be unloaded simply by connecting high-pressure gas into the tubing. (3) The need of pulling the side-door choke to permit circulating is eliminated. (4) Both zones may be circulated in after the packer has been set and tubing connections permanently installed. (5) It provides simple but positive means to circulate mud from above a packer in a single-zone well. A. H. N.

921.* **Overcoming Tendency of Packer to Stick in Casing.** F. H. Love. *Petrol. Engr*, July 1942, **13** (11), 13–24.—A troublesome problem connected with the use of packers in oil- and gas-wells is the tendency of packing element or sleeve to vulcanize to the casing, caused by high temperatures existing in wells of certain areas. To remove the packer thus stuck frequently develops into a difficult operating problem, and almost invariably results in a torn and worthless packing element.

To overcome this difficulty, and at the same time provide a packer with an effective seal, one manufacturer began experimenting 2½ years ago. The result is a lubricant-impregnated packing element. The element is made of neoprene, and the lubricant is milled and moulded into the construction in such a manner that under heat and load the sleeve "sweats" its own lubrication and prevents vulcanizing to casing even at temperatures as high as 300° F. The packing element has internal metallic reinforcing which imparts added strength and ensures multiple ring expansion for effective packing. The packer is described in some detail, with illustrations, and its use is discussed. A. H. N.

922.* **Petroleum Engineering.** Part 7. L. C. Uren. *Petrol. Engr*, July 1942, **13** (11) 25.—Professor Uren concludes his paper on the education of petroleum engineers in the U.S.A. by surveying the possibilities of and requirements for getting a job in the industry immediately after graduation. A. H. N.

923.* **Reworking California Oil-Wells.** W. A. Sawdon. *Petrol. Engr*, July 1942, **13** (11), 21–22.—The effect of war demands on Californian oil-fields is briefly discussed. According to the O.P.C. report, it appears that the present rate of productive capacity of heavy oil should be maintained at more than 300,000 brls./day, but that the normal annual drilling programme in the heavy-oil fields will not provide a sufficient number of wells to maintain this capacity. The development rate in these fields should therefore be increased, and the report recommends that: (1) Wildcat drilling be encouraged in every possible way, and top primary assistance be given for the drilling of exploratory wells. (2) All economically producible wells be rehabilitated and equipped where necessary. (3) The development of undrilled acreage, in fields capable of producing heavy oil, be stimulated to meet the demand made on this most important source of fuel oil.

As the immediate demand for more heavy oil is caused by the war, such oil that cannot be produced within the next few years will be of little value to the present war

effort. California heavy-oil fields require close spacing to produce a high percentage of recoverable oil in the desired period of time, and the report made by the district office of the O.P.C. suggests that old pools with undrilled areas and pools in the primary development stage be drilled with one well to 10 acres, but that the well-spacing pattern provide for secondary development of one well to 5 acres; that undrilled single locations in old pools be drilled according to the uniform spacing already prevailing; and in drilled areas of old pools, where closer spacing is justified by the remaining reserves and the steel factor, the spacing for additional drilling be variable to allow for subsurface conditions. Work in California is described in particular in connection with the reworking of wells. A. H. N.

924.* Reservoirs under Hydraulic and Volumetric Controls. A. H. Nissan. *J. Inst. Petrol.*, July 1942, **28** (223), 146–157.—An anomaly appeared to exist in deriving the velocity-pressure relationship, for reservoirs under volumetric or hydraulic controls, by two methods. The two equations were $Ve = KP^{\frac{1}{2}}$ and $Ve = KP$. A study of the two methods reveals the fact that the assumption made in applying only orifice equations to the problem are not justifiable, and that if a truly representative model be constructed, the anomaly disappears and a single equation is the result:

$$Ve = K_1P_1 + K_2P_2^{\frac{1}{2}}.$$

It is further shown that P_2 is negligible in oil reservoirs under volumetric or hydraulic controls, and therefore the equation becomes $Ve = KP$. A. H. N.

925.* The Value and Accuracy of Field Measurements. C. J. May and R. Pike. *J. Inst. Petrol.*, July 1942, **28** (223), 133–140.—A discussion of the desirable order of accuracy and of types and sources of errors in field volume and pressure measurements on producing wells is presented. A. H. N.

926.* Calculation of Load and Stroke in Oil-Well Pump-Rods. Part 1. B. F. Langer and E. H. Lamberger. *Oil Gas J.*, 2.7.42, **41** (8), 27.—*Paper Presented before Society of Mechanical Engineers.* Sucker-rods used in oil-wells can have a prolonged lift if they are operated in a manner which will prevent shocks and over-loading. This article deals with formulæ recently developed for the determination of these factors. The sucker-rod pump as used in oil-wells is treated as a problem in longitudinal vibration of bars. Solutions are obtained for the forces and motions at both ends of the rod-string, thus giving formulæ for the calculation of polished-rod load and plunger travel. The results of the calculations are compared with test results.

When making calculations in the field, it is not convenient to use the formulæ given. It is possible to simplify those formulæ for use over a limited range of conditions by assuming no damping in the rod-string. The authors did this, and at the same time modified the constants to make the calculated results agree more closely with the test results. The field formulæ thus derived are given. They agree with test results more closely than the complete formulæ in the range which the tests cover but must be used with caution for abnormal conditions.

$$PPRL = W_R - W_{Rb} + W_{OD} + 45SN\,[17A_R \tan{(0{\cdot}002LN)^0} + A_o].$$

$$EPS = \frac{S}{\cos{(0{\cdot}002LN)^0}} - \frac{W_{OD}L}{24(10^6)}\left[\frac{1}{A_R} + \frac{1}{A_T}\right].$$

where $PPRL$ = peak force at polished rod; W_R = weight of rod-string; W_{Rb} = buoyant force on rods; W_{OD} = differential fluid load = load due to net fluid-head on full area of plunger; S = polished-rod stroke; N = strokes/sec.; A_R = area of rod cross-section; L = total length of rod-string; A_o = area of fluid cross-section = net area of plunger; EPS = effective plunger stroke; and A_T = area of cross-section of tubing wall. All dimensions are in inches, pounds, and seconds. A. H. N.

927.* Development, Operation, and Valuation of Oil and Gas Properties. Part 6. P. J. Jones. *Oil Gas J.*, 2.7.42, **41** (8), 34–35.—This section deals with the flow of gas-oil mixtures through media of uniform permeability. Equations and graphs are reproduced and examples are worked out. A. H. N.

928.* Marine Christmas Trees Require Special Protection. G. B. Nicholson. *Oil Wkly*, 6.7.42, **106** (5), 21.—In the event of damage occurring to a christmas tree, and a well

blows out, either by external damage or defective equipment, oil companies use every possible safeguard against catastrophic effects of waste and pollution, protecting not only their own interests, but also the welfare of many families whose livelihood depends on fish and oysters living in the waters. To care for possible unavoidable damage of this nature, general practice in marine fields includes use of safety valves, usually placed in the tubing near the bottom of the hole, and designed to reduce or cut off flow automatically before harm is done. Casings are packed off.

The use of pilings and boards and other precautions against the elements are described, and are illustrated by several photographs of typical well-heads. A. H. N.

929.* Calculation of Load and Stroke in Oil-Well Pump-Rods. Part 2. B. F. Langer and E. H. Lamberger. *Oil Gas J.*, 9.7.42, **41** (9), 26.—Test data on a well are summarized, and the results are compared with those calculated by formulæ developed in the previous part. The well was specially selected. It was an abandoned, "dead" well, quite straight, quite constant as to casing fluid-level, with fluid being chiefly salt water (specific gravity 1·04) with only a trace of oil. The tests were conducted in such a way as not to disturb the fluid-level to any appreciable degree.

The formulæ developed are compared with A.P.I. and with the Mills formulæ.

In conclusion, it is stated that peak polished-rod loads and effective plunger strokes in an oil-well can be calculated by using the following formulæ: (1) Complete formula for peak polished-rod load:

$$PPRL = W_R\left(1 + \frac{ESK_1}{288L^2\delta_0}\right) + W_0\left(\frac{E_0\,\omega\,S_P}{144\mu_0 L_0}\right) + 2W_{0D} - W_{RB}.$$

(2) Field formula for peak polished-rod load:

$$PPRL = W_R - W_{RB} + W_{0D} + 0{\cdot}75SN\,\{17A_R \tan{(0{\cdot}0004LN)^\theta} + A_0\}.$$

(3) Complete formula for effective plunger stroke:

$$EPS = \frac{S}{R} - \frac{24LW_{0D}}{E}\left[\frac{1}{A_R} + \frac{1}{A_T}\right].$$

(4) Field formula for effective plunger stroke:

$$EPS = \frac{S}{\cos{(0{\cdot}0004LN)^\theta}} - \frac{W_0 L_D}{2(10^6)}\left(\frac{1}{A_R} + \frac{1}{A_T}\right).$$

The strokes and areas are expressed in inches, forces and weights in pounds, the well depth L in feet, and the pumping speed N in strokes/min. These dimensions are commonly used in the oilfields. Values of K_1 and of $1/R$ are given in figures. The results calculated by the foregoing formulæ agree closely with test values obtained from a comprehensive test programme, carefully carried out on a single well. It is believed that data determined by tests made with similar care on wells at other depths, or under other operating conditions, will also closely agree with calculated values. Such comparisons are invited.

Appendices give formulæ for the acceleration of fluid columns and for the natural frequency of stepped rods.

[*N.B.*—See Abstract No. 926 for Part 1 of the Paper.] A. H. N.

930.* Development, Operation, and Valuation of Oil and Gas Properties. Part 7. P. J. Jones. *Oil Gas J.*, 9.7.42, **41** (9), 25.—This part of the paper deals with the flow of gas–oil–water mixtures through media of uniform permeability. The work of Loverett and Lewis on 2-phase and 3-phase flow is summarized. A. H. N.

931.* Development, Operation, and Valuation of Oil and Gas Properties. Part 3. P. J. Jones. *Oil Gas J.*, 11.6.42, **41** (5), 35.—Formulæ are developed and graphs presented for the flow of homogeneous fluids through porous radial systems of uniform permeability. Pressure recovery in closed wells is studied. A. H. N.

932.* Factors Affecting the Volumetric Efficiency of Sucker-Rod Pumps. G. M. Stearns. *Oil Gas J.*, 11.6.42, **41** (5), 41–42.—Based on field experience, reported investigations and deductions, the factors listed below have been chosen as the conditions that may possibly influence the volumetric efficiency of a sucker-rod pump:

(1) Inherent well conditions: (*a*) amount of gas in solution in the fluid being pumped that may be reduced from solution between the valves of the pump; (*b*) viscosity of the pumped fluid; (*c*) temperature of the fluid being pumped; (*d*) foam accumulation in the well-bore; (*e*) well depth; (*f*) suspended solids in the fluids; (*g*) density of the pumped fluid. (2) Pump design: (*a*) size and shape of valve openings; (*b*) minimum clearance volume between valves; (*c*) plunger fit; (*d*) type of check (ball, drop, plumb bob, etc.); (*e*) size, length, and design of gas-anchor; (*f*) plunger length; (*g*) plunger surface—*i.e.*, (i) metal *versus* leather or composition, or (ii) grooved metal *versus* plain metal. (3) Pump operation: (*a*) length of stroke; (*b*) valve spacing; (*c*) pumping speed; (*d*) submergence.

These factors are discussed in brief. A. H. N.

933.* Review of Ultimate Recovery Factors and Methods of Estimating. S. F. Shaw. *Oil Wkly*, 13.7.42, **106** (6), 16.—An historical review is presented at the beginning of this long paper. There are five methods employed for estimating ultimate recovery: (1) Arbitrary estimates of barrels/acre, or barrels/acre-foot, based on recovery from fields with supposedly similar conditions. (2) Estimates based on volumetric, or saturation, contents of the reservoir. (3) Estimates based on decline curves constructed by plotting production against elapsed time. (4) Estimates based on the initial production of the well produced at maximum capacity for one day, or on the average daily production of the first year multiplied by a factor. (5) Estimates based on plotting the decline of reservoir pressure against the accumulated production.

Each of the methods is critically reviewed, with references to original papers on the subject. The conclusions reached from this review are as follows: (1) Factors for determining the ultimate recovery of oil are many and varied, and are as yet far from being thoroughly understood. (2) Methods of estimating ultimate recovery of oil are far from being perfect, but are gradually being improved as a better understanding of the various factors is obtained. (3) The most satisfactory method of estimating oil reserves yet devised is that obtained from elapsed-time-production decline curve on logarithmic cross-section paper, but this method may be affected by changes in methods of production. This method of estimation cannot be used satisfactorily when production is at a restricted rate. (4) The tendency of the elapsed-time-production graph for estimating reserves seems to be on the conservative side, while that of estimation by volumetric or saturation method seems to result in an exaggerated estimate. (5) Percentages of 10–20% recovery, as stated in early days, was only an opinion, and applied only to shallow reservoirs with tight formation rock and only to primary methods of production. It was the best expression of opinion obtainable in early days, based on the scanty evidence available at that time. Such a figure never has had, nor does not now have any application to recoveries obtained in the average producing fields of the U.S.A., and should never be used as a basis of comparison for different methods of production. A. H. N.

934.* Water-Heater System Prevents Freezing of Regulator Valves. G. B. Nicholson. *Oil Wkly*, 13.7.42, **106** (6), 14.—To prevent freezing of valves, orifice, or other units of a regulator on a gas-well, one company uses a special heater in which parts of the regulator prone to freeze are kept submerged in a vat filled with hot water, with heating element consisting of an inexpensively constructed underground pipe fed by a flame regulated by a pilot light and using gas from the separator.

Important element of the heater consists of a vat, 13 ins. deep and 24 × 36 ins. in lateral dimensions, set in a shallow pit. Constructed of firebrick and lined with mortar, the vat is water-tight and filled with water at all times. Regulator sets in the hot water, with the orifice and parts of the regulator body under the surface, and freezing on downstream side of the orifice is prevented.

Water in vat is maintained at proper level by an overflow consisting of a ¼-in. pipe extending through the wall of the vat 1 in. below top, opening into a concrete drain set at a slight angle in the ground. On end of the ¼-in. nipple, fittings are connected for attaching another nipple about 1 in. long, arranged in swing-fashion to stand vertically, or to be adjusted to any desired level not exceeding top of the vat. Height of this pipe determines level of the fluid inside the vat, with excessive water overflowing automatically through the drain, and following the ditch to a shallow excavation or gathering pit, where it is later picked up and returned to a storage drum.

Water requirements are low as little waste occurs, temperature of the water seldom attaining point where evaporation is acute. The rest of the equipment is described.
A. H. N.

935.* **Development, Operation, and Valuation of Oil and Gas Properties.** Part 8. P. J. Jones. *Oil Gas J.*, 16.7.42, **41** (10), 44.—The paper deals with recovery from gas reservoirs, detailing some of the gas laws and compressibility data. Pseudo-criticals are discussed, together with the mechanism of recovery by gas expansion. Data are presented graphically and formulæ are given in full. A. H. N.

936.* **Review of Secondary Recovery in the United States.** Part 2. P. D. Torrey. *Oil Gas J.*, 16.7.42, **41** (10), 39.—Secondary-recovery methods in Oklahoma (water-flooding), Texas (air and gas repressuring), and the Rocky Mountain States are reviewed. It is concluded that successful secondary-recovery operations in the U.S.A. are restricted largely to fields where primary recovery has been obtained by the action of internal gas-drive. Fields in which active natural-water drives are in operation are generally not adapted to secondary-recovery operations on account of low residual oil content. It should be pointed out also that better reservoir efficiency in more recently discovered internal-gas-drive fields should eliminate in some part the necessity for future application of secondary-recovery methods. If oil had been produced efficiently in many of the older fields, it is doubtful whether there would be such a high present activity in secondary-recovery operations. Therefore, secondary recovery, in a certain sense, is the correction of past mistakes, and with the knowledge that mistakes have been made, it should be possible better to avoid them in the future development and operation of oilfields. In this, studies of primary pressure control will undoubtedly play a very important part.

A study of oil reserves available from secondary recovery in the U.S.A. is presented.
A. H. N.

937.* **Development, Operation, and Valuation of Oil and Gas Properties.** Part 9. P. J. Jones. *Oil Gas J.*, 23.7.42, **41** (11), 35.—This part forms a continuation of the discussion on recovery from gas reservoirs begun in Part 8. Problems of recovery under water encroachment, and under partial water-drive with no by-passing are discussed. Economic limits for abandonment pressures and productions are studied.
A. H. N.

938.* **Electrolytic Chlorinators Used on East Texas Disposal Projects.** T. P. Sanders. *Oil Gas J.*, 23.7.42, **41** (11), 31–32.—Chlorine and chlorine compounds, widely used to eliminate sulphate-reducing bacteria and algæ at water-disposal projects in the East Texas field, have recently become practically unobtainable. As a result, East Texas operators are adopting an electrolytic process for liberating chlorine directly from the salt of the oilfield brine. Five disposal plants, operated by three different major companies, have already installed electrolysis equipment, and all other west-side operators having water-disposal wells are now planning similar installations.

Electrolytic chlorination consists of placing a series of carbon electrodes in a trough where the salt water will flow at a fairly uniform rate. With direct current of high amperage and low voltage, the reaction is made to take place, breaking down a small portion of the salt (sodium chloride) in the water. Chlorine is liberated as a gas at the positive pole, while sodium is liberated at the negative pole. However, the sodium combines with water instantaneously during the reaction to form sodium hydroxide. This reaction liberates hydrogen from the water, so a gas can be seen bubbling up from both positive and negative poles.

Because of the constant flow of water around the poles, the chlorine is quickly absorbed, and the portion escaping as gas is considered insignificant. Proper treatment calls for generating a slight excess of chlorine. Trouble was expected from the formation of sodium hydroxide in the water, but there has been none. It is believed that this alkali reacts with the magnesium and calcium carbonates present to form sodium carbonate and water, thereby being neutralized immediately.

The working of typical plants is described. A. H. N.

939.* **Recovery of Gasoline Stored in Laboratory Crude Reservoirs.** H. Vance and P. Martin. *Oil Gas J.*, 23.7.42, **41** (11), 33–34.—This paper deals with the recovery of gasoline injected into artificial crude-oil reservoirs on a laboratory scale. Attempts were made to duplicate as near as possible within the laboratory actual field conditions

which would exist around one well in a field under gravity drainage alone. The equipment is described.

The crude oil used throughout these experiments was from the East Texas field and had a gravity of 35·8° A.P.I. The gasoline used was commercial third grade, having an A.P.I. gravity of 50·2°. The sand was from an outcrop of the Yegua sandstone; it had a sand-grain analysis similar to the productive Woodbine sand in the Cayuga field in Anderson County, Texas, but slightly coarser.

In each case the sand was first dried and then dampened with water having the same chemical composition as the Woodbine water produced from the East Texas field. The water-wet sand was sifted into the reservoir, and after the sand had stopped setting, the excess crude oil was drained off, leaving the pore spaces saturated with crude oil and water. During the depletion of the sand, natural gas saturated with gasoline filled the top of the reservoir above the sand-face, allowing natural gas to enter the pore-space as it was depleted of its oil. This gas was then displaced as the pore-space was resaturated at a uniform rate with gasoline or a mixture of gasoline and crude oil.

Recovery data are presented graphically. About 30% more crude oil was recovered after injecting gasoline than was recovered by normal production methods. Neither the crude-oil saturation at the time of injecting gasoline nor the point of gasoline injection has much effect on the percentage of crude-oil recovery. The most favourable results from the standpoint of recovery injected gasoline were obtained by injecting the gasoline in the bottom one-third of a sand having low crude-oil saturation. Under these conditions there was an increase in crude-oil recovery of 25%, and 29·3% of the injected gasoline was not recovered. A. H. N.

940.* Development, Operation, and Valuation of Oil and Gas Properties. Part 10. P. J. Jones. *Oil Gas J.*, 30.7.42, **41** (12), 163–164.—The paper illustrates how the volume factors determined by Sage and Lacey, in their work on oil-gas mixtures under Research Project 37 of the American Petroleum Institute, can be used to make accurate estimates of oil recovery by either gas-expansion or water-drive. Equations are formulated and graphs are plotted based on the use of these factors. A. H. N.

941.* War Conditions Change Trend of Production Practice. H. F. Simons. *Oil Gas J.*, 30.7.42, **41** (12), 154–155.—Some of the outstanding things brought to the fore during the past six months include such equipment and ideas as: (1) Calipers which can be run in a bore-hole to determine its diameter from top to bottom. (2) The storing of butane in depleted horizons. (3) The use of an electrolytic chlorinator to remove sulphate-reducing bacteria from salt water which is to be disposed in a subsurface formation. (4) The application of gravel-packing as a means of eliminating troubles and increasing production in fields which are almost depleted. (5) Accurate instruments for measuring the weight and viscosity of drilling fluid and more complete instrumentation generally of drilling rigs. (6) More efficient equipment for the desulphurization of gas in sour-gas fields. (7) A new method of multi-zone completion which calls for running a succession of liners beginning at the bottom of the hole. (8) A triplex mud-pump which increases the fluid volume moving through the drill-pipe and well-bore approximately 50%. (9) An evaporator which permits a steam rig mounted on a barge to use sea-water for the boiler-feed. (10) An automatic spider and slip arrangement for handling rotary drill-pipe. (11) Studies on pump operation to increase the efficiency and reduce the number of breaks in sucker-rods. (12) A better understanding of the causes of drill-pipe and tool-joint failure. (13) Wider use of double-box and double-pin subs for connecting joints of drill-pipe. (14) More efficient use of all types of logging, including electrical, mud analysis, and time. (15) Redesign of reverse circulating rotary rigs which allows them to be used for clean-out and completion work. (16) A new type slim-hole rig, wheel-mounted and propelled while moving by the drilling engines. (17) Greater centralization of lease equipment. (18) Electrical and steam heating of tubing to remove paraffin or prevent its deposition. (19) Further experimentation with fibre-pipe in a shallow well using this type of tubular equipment for casing and a greater application being made of this material for salt-water gathering lines. (20) Use of carbon monoxide as a tracer in repressure projects. (21) Use of reabsorber gases from gasoline plants for field fuel. (22) Automatic tank batteries which do not require the constant attention of a pumper or switcher. (23) Use of citrous-fruit pulp as a viscosity-reducing agent in

drilling mud. (24) A wider use of torque convertors for increasing the life of internal-combustion engines. A. H. N.

942. Patents on Production. J. R. Betts. U.S.P. 2,284,632, 2.6.42. Appl. 31.5.39. Centrifugal pump with a well casing and having water-lubricated bearings.

A. Boynton. U.S.P. 2,284,634, 2.6.42. Appl. 31.1.39. Pneumatic piston-pump of the differential type for oil-wells.

R. T. Knapp. U.S.P. 2,284,908, 2.6.42. Appl. 10.1.39. Deep-well pumping mechanism utilizing liquid pumped under pressure.

A. S. Parks. U.S.P. 2,285,049, 2.6.42. Appl. 27.1.39. Means for purging flowing wells.

M. P. Burke. U.S.P. 2,285,109, 2.6.42. Appl. 8.6.39. Displacement-valve gas-lift system and apparatus.

H. C. Pyle. U.S.P. 2,285,169, 2.6.42. Appl. 27.1.38. Well-pump with a special type of gas separator attached to the inlet side.

L. Davis. U.S.P. 2,285,256, 2.6.42. Appl. 4.6.41. Pressure pump for oil-wells.

D. H. Larsen. U.S.P. 2,285,291, 2.6.42. Appl. 15.1.40. Gravel-packing of wells using an emulsion at least one of whose phases is soluble in petroleum.

C. C. Carlisle. U.S.P. 2,287,779, 30.6.42. Appl. 18.9.40. Deep-well pumping mechanism with a reversing valve.

H. J. Pankratz. U.S.P. 2,288,142, 30.6.42. Appl. 27.3.41. Well-pump with a special fluid-accumulation chamber.

R. C. Boughton. U.S.P. 2,288,225. 30.6.42. Appl. 24.2.41. Pipe-coupling.

E. C. Kopp. U.S.P. 2,288,245, 30.6.42. Appl. 9.1.40. Oil and gas separator with special type of baffles.

L. W. Vollmer. U.S.P. 2,288,556, 30.6.42. Appl. 28.6.39. Method of and composition for producing permeable packs in wells.

L. W. Vollmer. U.S.P. 2,288,557, 30.6.42. Appl. 20.6.40. Method of and composition for producing permeable cement packs in wells. A. H. N.

Transport and Storage.

943. Evaporation from Gasoline Storage Tanks. C. L. Marner. *Refiner*, May 1942, 21 (5), 147–149.—Evaporation losses from gasoline tanks result in: (1) decrease in vapour pressure (affects starting); (2) increase of 10–50% boiling point (affects acceleration and performance); (3) decrease in octane number.

Practically all data covering evaporation have been based on the theory that the loss occurring is directly proportional to the vapour pressure of the product and the surface area of the tank in which the product is stored. However, later information indicates that evaporation loss is directly proportional to the vapour pressure of the gasoline and the capacity of the tank. The loss being correspondingly greater from smaller tanks than from the larger ones. One of the major oil companies recently completed tests which proved that with 10 ft. or more of outage from a tank, the evaporation loss remained the same regardless of the amount taken out. This is undoubtedly true because the most important factor in breathing is the increase in the vapour pressure of the gasoline as its temperature increases. This effect is in addition to the expansion of the vapour caused by increase in temperature. The closer the gasoline-level to the top of the tank, the higher the surface and vapour-space temperatures, as well as a correspondingly greater fluctuation in temperature range, and any vapours expelled during breathing would be considerably richer due to the higher surface temperature and the smaller space to be saturated.

Tabulated data show typical losses obtained in tests by fourteen large oil companies. Losses by windage, breathing, filling, and boiling are discussed. Filling losses may be eliminated by using floating roofs or by having the vapour spaces of all tanks manifolded together, and then to a gas reservoir or to a comparatively limited number of tanks equipped with expansion or variable-space roofs having sufficient capacity to equal difference in volume of gasoline produced and shipped/day plus the proper

allowance for breathing. One major oil company using this method for the past several years reports that tanks containing sweet and sour products have been manifolded without any evidence of contamination of either product.

Breathing may also be eliminated by storing motor gasoline in 3-lb. pressure vessels. When pressure tanks are used the total cost for complete protection is considerably higher than when manifolding cone-roof tanks to roof of the variable-space type, because each unit must be of the pressure type.

Inhibitors are used in gasoline to prevent oxidation of unsaturated hydrocarbons, and thus eliminate formation of gum. Some of these inhibitors are soluble in water. Thus, when water comes in contact with gasoline, the inhibitor losses its effectiveness, and as a result, objectionable quantities of gum are formed. A. H. N.

944. Practical Methods for Storing Volatile Liquids. D. E. Larson. *Refiner*, July 1942, **21** (7), 217–225. *Paper Presented before American Institute of Chemical Engineers.* —The requirements of storage for these liquids are : (1) Retaining each product for the required period of time without deterioration or loss of quality. Some liquids may become contaminated or go " off specification " unless properly protected from contact with air, water, dust, or other foreign substances. (2) Retaining the product without loss of volume. Evaporation and leakage are the primary sources of loss from storage containers. Losses from both sources can be eliminated by selecting the type of container best adapted to the service for which it is to be used. (3) Storing the product at the lowest possible cost/gal. commensurate with safety. As a rule, the type of container most nearly fulfilling the requirements listed above will provide the most economical storage even though its first cost is higher than that of other types. (4) Storing the product with the least possible danger from fire. Where defence materials are concerned, the ever-present threat of sabotage makes the problem of protection doubly important. Fires must be prevented from starting and spreading.

Five basic types of tanks are : (1) atmospheric tanks with fixed roof ; (2) tanks with variable-volume vapour spaces ; (3) floating-roof tanks ; (4) pressure tanks ; (5) underground storage tanks.

After a detailed examination of various types of losses, it is concluded that the classes of service to which each of the five basic types of storage containers are best adapted may be summarized as follows : (1) Atmospheric tanks with fixed roofs equipped with conservation vent-valves are suitable for products of low volatility such as fuel oil, kerosine, and heavy crude oil. (2) Tanks with roofs which provide a variable-volume vapour space are used most advantageously in these ways : (*a*) breather roofs provide economical storage for light products such as motor gasoline or light crude oil in tanks which normally remain full or nearly full ; (*b*) balloon roofs, which have a relatively large volume, afford the lowest-cost storage for motor gasolines and similar products in slow-working tanks which are filled and then emptied gradually over a period of several months. (3) Floating roofs provide the most economical means for storing motor gasolines, light crude oils, and other products of similar volatility in active tanks which are worked either continuously or intermittently. Floating roofs are also recommended for installation in which reduction in fire hazard is one of the prime considerations in selecting the type of tank. (4) Pressure tanks such as spheres and spheroids afford the only practical method for storing natural gasoline, isopentane, butane, and other light products which would suffer enormous losses from boiling in ordinary storage tanks. (5) Underground storage is much more costly than above-ground storage, and is used primarily for installations in which concealment is necessary for defence purposes or where tanks must be placed below the surface to comply with city ordinances.

A discussion of the paper is appended. A. H. N.

Gas.

945. Butane Requirements Demand Efficient Extraction. R. W. Machin. *Refiner*, May 1942, **21** (5), 143–146.—Manufacture of natural gasoline by the absorption method is accomplished by three distinct steps. In the absorption plant the rich gas is contacted with oil in absorbers to remove the constituents desired in the finished products. After the oil has absorbed these constituents, the rich oil is passed successively through vent tanks, heat exchangers, and preheaters to the distillation unit, where, by a process

of distillation, the absorbed constituents are driven off by heat under pressure. The absorption oil is cooled by heat exchange and coolers to be recycled through the absorbers, while the light constituents absorbed from the gas are liquefied by cooling and accumulated in tanks.

From there the condensate is pumped to stabilizers, where the constituents are broken up into as many various products as the plant is equipped to segregate. The three units that make up the absorption plant are: (1) the absorption unit; (2) the distillation unit; and (3) the stabilization unit. In conjunction with these three units will be found such auxiliary units as the cooling-tower and boiler-house.

Each of the three units is discussed in some detail, together with the mechanism of absorption. The importance of temperature and pressure effects is explained. Other factors directly affecting absorption are the characteristics of the absorption medium, gas–oil ratio, velocity of gas through the column, kind of gas, and design of the equipment. Perhaps as important a factor as temperature and pressure is the regulation of the gas volume and the oil rate, so that both will be as nearly consistent as is possible. It has also been found by many operators that when the oil–gas ratio is higher or lower than a certain definite point, maximum efficiency is not obtainable, and at that point of "maximum effect" is acquired the peak of plant production. A. H. N.

946. Importance of Butane in This War. R. L. Huntington. *Refiner*, May 1942, **21** (5), 127–130.—The production of butane from gas and crude-oil fields, from distillate fields and from secondary recovery operations is discussed briefly. Operations with vacuum on the casing-head are studied. The maintenance of present equipment free of trouble is analysed under three headings: (1) Scale prevention and removal; (2) importance of clean absorption oil; and (3) water supply. Under the third item it is pointed out that prevention of scale can be had in three ways: (1) By water treatment calling for the precipitation and removal of scale-forming chemicals before water enters the plant system. (2) By adding a colloid which will keep the scale-forming compound in suspension until the concentration becomes great enough to warrant a renewal of raw water within the system. (3) By use of zeolite treatment, in which hard salts are converted into non-scale-forming salts of sodium.

A brief study of oil absorption is then given, discussing pressures, temperatures, number of theoretical plates, and type of absorption oil. Certain general rules for the type of oil to be selected are given. (1) The oil should have an initial boiling point well above the end-point of the raw natural gasoline, so that the oil will not distill over with the gasoline. (2) The oil should be free of heavy ends which may cause too high a pour test thereby resulting in solidification of the oil in the cooling coils. (3) Waxy hydrocarbons should be absent (or present in very small amounts). Heavy asphaltic fractions may promote the formation of emulsions which are highly undesirable. (4) The number of mols./unit of liquid volume should be a maximum. This result usually can be accomplished by selecting a low-molecular-weight oil. An example is worked out. (5) The absorption oil should be one from which the gasoline constituents can be readily denuded or stripped out in the still. (6) In high-pressure absorbers operating at 600 lb. or more, higher molecular-weight oils are recommended since there is a tendency for vaporization to take place in the retrograde region, especially for the lighter oils. A. H. N.

947. A Suggested Standard Method for Calculation of High-Pressure-Gas Measurement. D. L. Katz. *Refiner*, June 1942, **21** (6), 170–176.—A standard procedure for converting orifice-meter readings on high-pressure gases into quantities of gas flowing is desirable for the natural-gas and natural-gasoline industries. Such standards have been used for low-pressure gases for many years, and cover most of the procedures for high-pressure gases. The chief item on which complete agreement has not been reached is the correction for deviation of the gas from ideal gas laws. The compressibility-factor method is generally accepted, and the lack of agreement lies in the method of choosing this compressibility factor for specific cases. The prime purpose of this paper is to suggest standard procedures for selecting water-correction factors to account for the compressibility of the gas flowing. A brief discussion of measuring the flow of two phases is included. The following procedures for establishing standard meter factors including the deviation from ideal gases are as follows, depending on the accuracy desired: (1) For the highest degree of accuracy, a gas analysis should be obtained to

eliminate any doubt as to pseudo-criticals. The errors in metering due to gas density alone should not exceed 1% on the average. (2) For average metering of high-pressure gases of varying gravity, representative analyses should be obtained to be used to establish a curve of gas gravity *v.* pseudo-critical temperature and pressure. From this curve a chart or series of tables should be prepared, giving the meter factors at even gas gravities. The errors in metering due to gas density alone should not exceed 2% on the average. (3) For cases in which analyses are not available, the meter-correction factors are recommended. These are illustrated. The error in metering due to gas density should not exceed 3% for the average gas, but an unusual gas at conditions to give low-compressibility factors might be in error by as much as 10%. (4) Further study of gasoline contents may indicate their usefulness for certain groups of gases in establishing the correct pseudo-critical conditions *v.* gas gravity. (5) Metering of gases above 1000 lb. known to contain less than 10% of liquid by volume should be computed as if the entire stream were a gas phase, provided the meter operation is indicative of uniform dispersion of the liquid in the gas passing through the meter run. (6) The compressibility-factor plot should be used for natural gases containing less than 7·5 N_2 and 2% carbon dioxide. For appreciably higher concentrations the measurement of the compressibility factors is recommended for reliable results. (7) The double importance of temperature because of its effect on compressibility factors as well as on the ideal volumetric expansion should be recognized in high-pressure measurement.

The paper is well illustrated by graphical compressibility data. A. H. N.

948. The Density of Natural Gases. T. A. Matthews, C. H. Roland, and D. L. Katz. *Refiner*, June 1942, **21** (6), 164–169.—Although one page is missing from the paper, enough of graphical and tabular data are included in the remainder to render it of value. Extensive graphs and tabulated data are presented for single and two-phase natural gases under conditions of pressure and temperature. A. H. N.

Synthetic Processes.

949.* Substitute Fuels as a War Economy. G. Egloff and P. M. Van Arsdell. *J. Inst. Petrol.*, July 1942, **28** (223), 115–132.—A systematic study of substitute fuels used by the belligerent countries is presented, based on statistics, official and Press statements. In conclusion it is stated that many types of motor fuels and substitutes are being used by the Axis Powers. There is a decided stringency in the allowable use of even substitute fuels, due to lack of raw materials, manufacturing facilities, and man-power for their preparation. The relatively poor quality of the Axis fuels has curtailed the manœuvrability of their automotive transportation, including aeroplanes.

A. H. N.

Refining and Refinery Plant.

950. Condensation Combined With Water Treating. Anon. *Refiner*, May 1942, **21** (5), 131.—The system includes condensation of steam from turbines, reboilers, and heaters in a special fan-cooled radiator unit. Water thus recovered is combined with raw feed, all of which is treated with chemicals.

Exhaust from the steam-powered and steam heating units is collected in an 8-in. line running through the main pump-room and connected to a horizontal 8-in. header across the top of the tube-and-fin condensing sections. The other end of the exhaust-steam line is connected to a pressure-operated hot well, from which an excess exhaust-steam line leads to a remote part of the plant. An automatic pressure controller on this line, set to operate at 15-lb. gauge, serves as a relief valve for the condensing system.

The system is maintained with an operating pressure of 10-lb. gauge, on the hot-well end of the exhaust line, and 5-lb. on the collection drum at the base of the tube-and-fin sections. Because of the pressure differential, a turbine-driven pump removes the condensate from the collecting drum by instrument control. The system has capacity of 14,000 lb. of exhaust steam/hr. under normal atmospheric conditions.

A. H. N.

951. Heat Transfer, Pressure Drop, and Fouling Rates of Liquids for Continuous and Non-continuous Longitudinal Fins. A. Y. Gunter and W. A. Shaw. *Refiner*, May 1942, **21** (5), 150–158. *Paper Presented before American Society of Mechanical Engineers.*—The data herein reported refer to pipe-within-pipe type units, and are not strictly applicable to other types of fin-tube units. The present paper has three objectives, as follows: (1) To furnish test data on liquids in laminar flow for long-continuous fins, correlated with published data and theoretical curves for air. (2) To indicate the advantage of non-continuous longitudinal fins over long-continuous fins for liquids. (3) To present analysis of the theoretical aspects of fouling on fin tubes, as compared with bare tubes, together with a presentation of actual fouling rates encountered in intermittent semi-plant-scale operations.

Full experimental data are presented and discussed, and are correlated especially with the works of Norris and Streid (*Trans. A.S.M.E.* (1940), **62**, 525–533) and of Norris and Spofford (*A.S.M.E.* Annual Meeting, New York, December 2, 1941). The general conclusions reached are, for heat transfer: (1) The use of non-continuous fin sections instead of long-continuous fins increases h_f in the ratio of 2 to 1, where $L = 1{\cdot}2$–10 ft. (2) Correlation to test data for liquids in this paper, where L/D_s is controlling, indicates the curve shown in Norris and Streid's Figure 4, are conservative above $R_s = 200$, because present test results show the transition range beginning at about this point. (3) The dimensionless function (μ/μ_w) 0·14 should be included in the J_s value when correlating viscous liquids.

For pressure drop: (1) The pressure-drop efficiency factor for non-continuous fins is comparable to that on long-continuous fins where $L = 1$–10 ft. (2) Correlation of test data on pressure drop in this paper with Norris and Spofford gives fair agreement in the range of $R_s = 700$–2000 for one sample.

For fouling rates: (1) From a theoretical viewpoint, fouling has less effect on fin tubes than on bare tubes, for as fouling increases, the fin effectiveness increases, tending to offset the fouling effect. (2) A fouling factor of 200 for longitudinal fin tubes in heavy-fuel service, with steam temperatures not above 350° F., will normally assure at least 1 year of service without cleaning. Intermittent operations or operations at less than design throughputs may shorten this period.

The test equipment and procedure are presented in full in an appendix.

A. H. N.

952. Protecting Plants in War-time. Anon. *Refiner*, May 1942, **21** (5), 139–142.—Deception through camouflage painting and complete blackout are the hindrance to bombing. Special lighting, adequate fencing, and alertness of the operating personnel are the counteracting measures used in anticipation of wilful damage. Together with these are emergency methods of shutting-down operations, diverting gas into the air or into other plant-lines, and protecting plant-forces.

Protection against bombing may be obtained to a degree with camouflage painting and colours containing pigments which cause the painted objects to blend into the colour of the soil and adjacent scenery. Many storage tanks, processing columns, and vessels which recently glistened with bright colours, are now toned down to the olive-drab of the Army. Paints are now being compounded containing special ingredients that prevent photographing with infra-red film, so that pictures taken from reconnaissance planes will not show the location of important installations.

In localities which have organized systems of raid information and adequate warnings, the sequence of the three principal alarms will provide sufficient time to extinguish all lights and blackout the plant. Lights of some sort are almost essential for operating the machinery, and in some plants the lighting circuits are being rearranged so that the master switches will cut off all but three or four outlets. These in turn are fitted with special blackout hoods which prevent illumination from being detected outside the building and concentrate the beams to a very narrow circle on the floor.

All these various items are detailed and certain of them are illustrated. A. H. N.

953. Design and Installation of Steel Tank-Bottoms by Arc-Welding. E. G. Woolman. *Refiner*, June 1942, **21** (6), 189–190.—In reconditioning tanks, safety must be given first consideration, in order to protect both men and materials. Tanks which have contained lighter petroleum fractions are more dangerous, but are more easily cleaned. Those containing heavier oils must be thoroughly cleaned. Steaming is the accepted

method of removing the bulk of the oils, followed by application and removal of fuller's earth applied to the bottom. These two steps result in a dry, gas-free tank.

A special method of installing steel tank-bottoms is described and illustrated by diagrams. A. H. N.

954. Heat Exchange Allows Increase in Cracking-Unit Charge. Anon. *Refiner*, June 1942, **21** (6), 191.—One of the latest additions to cracking facilities consists of two sets of heat exchangers. One is mounted on the vapour-condenser box and employed as a vapour-to-charge exchanger, which has resulted in recovering waste heat, and reducing the quantity of water for cooling and condensing the pressure distillate vapours.

In the crude charge flow the second set of exchangers is mounted on low concrete piers beside the residuum coolers, and is connected to the flow-piping with a manifold which provides for by-passing the exchanger or routing the crude charge from the vapour exchanger to the exchanger handling the residuum to recover waste heat at this point.

Advantages are briefly outlined. A. H. N.

955. Increasing Recovery of Liquefied Petroleum Gases in Natural-Gasoline Plants. J. W. Wilson. *Refiner*, June 1942, **21** (6), 176–181. *Paper Presented before Natural Gasoline Association of America.*—Statistical data about liquefied petroleum gases are presented. Theoretical considerations of oil-absorption plants are reviewed. Certain definite conclusions may be reached from this work: (1) For economical operation and maximum extraction efficiencies an absorber should have a minimum of twelve theoretical plates. (2) A sixteen-plate absorber of moderate plate efficiency will in general give better performance than an absorber of more elaborate design; but having a smaller number of plates. (3) Absorption factor is directly proportional to absorber pressure and oil rate, and inversely proportional to the molecular weight of the absorption oil, and to the vapour pressure of the individual component to be extracted taken at the temperature of the oil leaving the absorber. (4) For 99% extraction of normal butane with an absorber having twelve theoretical plates, a normal butane absorption factor of about 1·3 will be required. The *iso*-butane absorption factor in that case would be about 0·85, which means that only about 85% of the available *iso*butane would be absorbed from the gas. For complete extraction of *iso*butane the normal butane absorption factor will have to be increased to slightly less than 2·0.

Desirable qualities of absorption oil are listed as: (1) The molecular weight should be low, as absorption efficiencies increase with decrease in molecular weight of the absorption oil. (2) The oil should have a low average boiling point. (3) The boiling range should be short—*i.e.*, around 100° F. (4) The initial boiling point should be as low as practicable with the type of distillation equipment employed, but probably should not be below 400° F. in most cases. (5) The gravity should be between 38° and 40° A.P.I. (6) The oil should contain a low percentage of unsaturated hydrocarbons, due to their poor stability to heat and air. On the other hand, a high percentage of naphthene and paraffin hydrocarbons are desirable, as they are the best absorbents, and resist oxidation, or deterioration from heat. (7) The oil should be free from organic acids and refining agents. (8) The oil should have low pour and cloud tests. The pour point should be considerably below the lowest operating temperature. (9) The oil should be sulphur-free. (10) The colour should be 16–21 Saybolt as an indication of refinement.

Pressure, temperature, and economic factors in absorption are discussed.

A. H. N.

956. Mercaptan Reduction and Doctor Treating Combined. Anon. *Refiner*, June 1942, **21** (6), 185–188.—In the refinery at Santa Fe Springs, the raw-pressure distillate is stabilized to a Reid vapour pressure between 10 and 11 lb., where most of the hydrogen sulphide is removed in the stabilizer overhead discard. The first part of the pressure-distillate-treating plant is in two sections operating in series and continuously, beginning with the first contact between gasoline and the treating agent for the removal of hydrogen sulphide. This section is followed immediately by the second, where the mercaptans are reduced an average of 65% with a constant circulation of continuously regenerated caustic solution.

When treating a pressure distillate produced by cracking gas-oil and kerosine dis-

tillate, the caustic solution in the mercaptan section of the treating plant is held at a Be. gravity of 18°. When this solution loses its efficiency, it is dumped from the system, and part of the liquid pumped into the hydrogen sulphide stripping section. This section is a horizontal drum with connections and piping arranged with an eductor type tee which withdraws the solution from the lowest side of the drum by the velocity of the gasoline passing through the instrument. Both gasoline and caustic enter the drum at the top through an extension of the piping, which delivers the mixture to the low side where gasoline spreads through the bulk of the caustic as it separates and rises to the top, passing from the drum at the end opposite the connection where solution and gasoline enter.

The mercaptan reduction section contains seven vertical vessels, four of which are employed in the contact circuit and three as separators, removing caustic solution from the gasoline as it flows from the section to storage. The four vessels in the contact circuit are divided in pairs, the two pairs in series in the gasoline flow, and each pair working in parallel. Beyond the contact and scrubbing vessels is the caustic-regeneration system, where the mercaptans are released from the solution. Regenerated caustic is pumped from the regenerator cooling side to the second pair of contact vessels, working through a set of turbulence-forming tees and passing with the pressure distillate to the vessels, from which it is withdrawn by a pump and passed backwards to the first set of contact vessels. Meeting the hydrogen-free pressure distillate, the partly spent caustic breaks the edge of the mercaptans in the gasoline, and is removed through a single-level controller from both vessels. This is accomplished because both vessels are connected at their bases by a large pipe, to afford an unrestricted flow of solution from one vessel to that which is equipped with the liquid-level-control instrument. Gasoline from which the maximum of mercaptans have been removed flows through the separators to storage.

Regeneration of the caustic and doctor solution is described in detail. A. H. N.

957. Rôle of Chromium in Steels for Cracking-Still Tubes. C. L. Clark. *Refiner*, June 1942, **21** (6), 159–161.—While rigid restrictions are being imposed on the use of chromium in alloy steels, the addition of this element to steels for cracking-still-tube service is essential, mainly because the corrosion resistance to hot petroleum products is proportional to the amount of chromium present. Likewise, molybdenum must be added, for the straight-chromium steels are susceptible to temper embrittlement after service at elevated temperatures.

The severity of corrosion in different cracking units varies greatly, depending on the particular crude used and to some extent on the operation conditions. The grade of chromium steel required thus also varies, a higher chromium content being required the more corrosive the hot petroleum products. In order to meet these varying requirements, steels are available containing up to 9·0% chromium, as well as 18–8 and its several modifications for the most severe conditions. The resistance to corrosion is further discussed, as well as oxidation resistance. Chromium also has an influence on the high-temperature strength, but it is not true that the strength is proportional to the chromium content. From this it follows that a decrease in the chromium content does not necessarily decrease the strength, and in fact it may result in an improvement in this property.

There is not as yet general agreement as to the high-temperature-strength characteristics most suitable for design. Some use the creep resistance, while others resort to the rupture strength. Insofar as cracking-still tubes are concerned, the stress-rupture characteristics are believed the most suitable, for they not only afford a basis for design, but also show the behaviour of the steel under overheating conditions, and give an indication of the degree of bulging or deformation to be expected prior to the rupture of the tube.

NOTE.—*Refiner* numbers sent to Britain have page 16 cut by the Censor; but enough of the paper is left to be of value, as graphs are included. A. H. N.

958. N.P.S.H. and the Centrifugal Pump. L. H. Garnar. *Refiner*, July 1942, **21** (7), 196–200.—In centrifugal pumps an important point is to keep the pressure at the entrance to the impeller vanes above the vapour pressure of the liquid at all times. The energy available at the pump-suction flange to do this and to overcome pump suction losses is called "net positive suction head over the vapour pressure." This term is commonly abbreviated in use to N.P.S.H., and was originally used in con-

junction with pumps handling boiling liquids where all the available energy came from the static elevation of the liquid above the pump.

The pump manufacturer usually has the suction limitations of a given pump plotted in the form of a curve showing minimum N.P.S.H. requirements for all capacities in the operating range. As long as the available energy equals or exceeds these figures there will be no undue vaporization causing limited capacity, cavitation, and accompanying troubles. This means that for all practical purposes all values stated by the pump manufacturer for minimum N.P.S.H. requirements are based on: (1) The pressure drop from the suction flange to the impeller vane. Since the size of suction opening is usually unknown to the purchaser at the time of negotiation, this pressure drop includes the velocity head at the pump-suction flange. (2) All values quoted for N.P.S.H. required have been corrected to refer to the pump centre line. Since pumps may have top suction, side suction, end suction or bottom suction, such practice is of assistance for pre-engineering and comparison purposes. For preliminary use the pump-shaft centre-line can be assumed to be 3 ft. above the pump-house floor.

To make the best possible pump selection, all the information regarding operating conditions should be given to the pump-builder. Assuming that all other pertinent data have been furnished, the suction information should include: (1) pressure at the pump suction at the design capacity; (2) N.P.S.H. available at the pump suction at the design capacity; (3) if there is a static lift its value should be stated; (4) the value of the vapour pressure is desirable, but it is not essential if the above data are given.

The determination of N.P.S.H. is discussed and five examples are worked out as illustrations. A. H. N.

Metering.

959.* Oil-Well Meters. G. L. Paulus. *World Petrol.*, May 1942, **39** (5), 33.—In a long paper the principles of oil-well meters, their special problems as met in oilfields with wax, gas, sand, salt water, and scale, their installations are all studied in some detail. Positive displacement, current, and weigh-meters are discussed. The calibration and checking of meters are also studied.

In comparing the cost of gauging well production by means of oil-meters or gauge-tanks, the policy of individual companies must be considered. This policy may often be influenced by lease requirements. To arrive at the relative investment required for tank-gauging facilities and oil-meters, it can be assumed that two 250-brl. gauge-tanks will be required for each well and one meter installation/well. Comparing the installed cost of the tank with the installed cost of the oil-meter, there is a marked saving possible in the oil-meter. Oil-meters vary in price from about $25 to $500. Most wells can be handled by a meter costing in the neighbourhood of $150—at least, this is a good average cost for the purposes of comparison. Detailed cost comparisons are given for typical cases which show results in favour of the meter.

On a lease where positive displacement meters have been used for a number of years, the monthly net production arrived at by means of daily-production records based on meter readings has checked actual net produced within less than 1%, month after month. The lease has about seventy active meters, and no other well-gauging facilities are available. A. H. N.

Chemistry and Physics of Hydrocarbons.

960. Vapour-Liquid Equilibria for Hydrocarbons. C. D. Shiah. *Refiner*, May 1942, **21** (5), 134.—A review of previous work is given. Cox's and Lewis's work on vapour pressure and fugacity is made the basis of the theoretical considerations of the paper. Based on these considerations, a chart is prepared to represent vapour–liquid equilibrium constants for all hydrocarbons at all temperatures and pressures. For compactness and ease of application, this single chart excels all other forms of presentation. Of course this chart can be no more accurate than the experimental data and calculated results from which it is derived, but as more accurate and complete data becomes available, this chart can be easily adjusted accordingly.

The reason that *n*-pentane is chosen as the reference compound is simply because its vapour–liquid equilibrium constants, which have been determined by Katz and Cummings, cover a wider range and distribute more evenly on the chart. The use of this chart is self-explanatory. To find the value of K for a certain compound at a certain temperature, one has only to find the corresponding temperature for *n*-pentane

to have the same value of K from right-hand half of the chart. The K of n-pentane at the specified pressure at this temperature, which is equal to the K of the compound at the temperature and pressure in question is read from the left-hand half of the chart.

Data from the chart are compared with that from other sources and found acceptable.
A. H. N.

961. An X-Ray Study of Carbon-Black. J. Biscoe and B. E. Warren. *J. appl. Phys.*, June 1942, **13** (6), 364–371.—X-Ray studies have been made of a number of carbon-blacks, prepared under different conditions, and subject to various heat treatments. The patterns were made in evacuated cameras, using CuKα radiation monochromated by reflection from rocksalt. The patterns consist of crystalline reflections (*ool*), and two-dimensional lattice reflections (*hk*). The structure is one of true graphite layers arranged roughly parallel and equidistant, but otherwise completely random. The dimensions within a layer are the same as in graphite; the layer separation is somewhat larger than in graphite. The effect of heat treatment is to increase the size of the parallel layer groups. At graphitization the material changes discontinuously to the crystalline graphite structure. The usual carbon-black is not finely divided graphite. Small-angle-scattering studies indicate the existence of clusters of a few hundred angstroms in size. It is these clusters which are measured by microscope counts, by the electron microscope, and by surface areas, rather than the much smaller parallel layer groups.
A. H. N.

962. Multicomponent Distillation. Graphical Method for the Estimation of Number of Theoretical Plates as a Function of the Reflux Ratio, Minimum Number of Plates, and Minimum Reflux Ratio. C. D. Shiah. *Refiner*, June 1942, **21** (6), 182–184.—A new graphical method is presented by which the curve of O/D *v.* the number of theoretical plates, sufficiently accurate for cost estimations, can be obtained when one set of rigid or approximate stepwise calculation data is available. This method makes use of the fact that the function of a multicomponent distillation is the separation of a complex mixture into two fractions. Thus any complex mixture can be considered as a binary mixture of the two fractions to be separated. An equilibrium curve can thus be drawn from the stepwise concentrate gradient data. McCabe and Theile's method can then be applied to determine the minimum reflux ratio, minimum number of plates, and number of plates at any reflux ratio.

An illustrative example is worked out.
A. H. N.

963. Photochemistry in Petroleum Technology. J. De Ment. *Refiner*, July 1942, **21** (7), 206–216.—The systematic classification of photochemical reactions is acknowledged to be difficult. Often one and the same reaction passes from one class to another, according to the experimental conditions, with vague boundaries of transition. However, photochemical reactions can be recognized as being of two kinds. In one, light usually accelerates a transformation which takes place to a lesser extent in the dark, with a diminution of free energy in the system. These are technically called exoenergetic reactions. In the other, the reaction cannot proceed alone unless light supplies the necessary energy. This second kind is the endoenergetic reaction.

With exoenergetic reactions the colour stability of gasoline, oils, and many lighter compounds can be interpreted. Also, gumming and formation of objectionable compounds in refined oil products may frequently be explained by the exoenergetic mechanism. On the other hand, the endoenergetic reaction can be considered to be of greater importance when it is remembered that many reactions take place on a much larger scale when energy is introduced into the system externally through the agency of light. The paper deals mainly with endoenergetic reactions.

The ideal source of light is extremely intense, and concentrated with efficiency and convenience. A concave mirror behind the source increases intensity. Best sources of light are the sun, which costs nothing, but which has several patent disadvantages; large carbon arcs; mercury-vapour lamps; metallic-vapour lamps other than mercury; and incandescent filament lamps. High-current-density high-potential sparks between metal electrodes are very good light-sources, since they emit short wave-lengths in abundance and at high intensity. The explosion of metal foils produces powerfully intense radiations. A very brilliant light, up to 14,000,000 candle-power, of extremely short duration is produced by the explosion in argon of a liquid explosive, such as tetranitromethane, the spectrum extending far into the ultraviolet. The use of X-ray

tubes, the cyclotron and radioactive substances as sources of energy is discussed. The principles of photochemistry and the law connecting photochemical effects linearly with the quantity of light absorbed are outlined. Generally, photochemical activity increases with a decrease in wave-length. This means that rays of greatest activity will be on the violet end of the spectrum, hence the assumption that X-rays and radium rays may soon be of importance in industrial photochemical processing. Conversely, rays on the red end of the spectrum usually have little photochemical action. Certain peaks are observed in the absorption bands.

The most effective approach in an attempt to process oil and petroleum products by light, therefore, is: first, a laboratory determination of the main absorption bands in the substances being worked for all wave-lengths, especially those in the ultra-violet region; second, to choose a light-source whose maximal emission occurs at the same region in the spectrum as the absorption bands in the oil; third, to apply the fundamental photochemical laws which describe the intensity of radiation, duration of exposure, thickness, and concentration of the reactants; fourth, to develop the process by actual experimentation with as much control as possible; fifth, to prepare a flow-sheet and processing diagram; sixth, to prove the process by small-scale operation, before any attempt at large-scale production is even considered feasible.

Fluorescence, catalysis, bleachings, cracking, stabilization, photo-polymerization, and photo-halogenation are each discussed in some detail. The long paper ends with special applications such as deodorization of refinery rooms by ultra-violet, treating moving belts with irradiation to discharge accumulated static electricity with safety, mist stabilization, etc. Seventy-three references are included in the bibliography.

A. H. N.

Lubricants and Lubrication.

964. Frictional Phenomena. Part X. Lubrication. A. Gemant. *J. appl. Phys.*, June 1942, **13** (6), 355–360.—The application of the viscosity concept to this technically important field is presented. Discussed first is film lubrication, which occurs when the film thickness is greater than 10 cm. This mechanism is chiefly controlled by the viscosity of the liquid. The basic mathematical theory is developed, and it is shown how this adequately describes the experimental facts. Next, boundary lubrication is discussed, a type occurring with stable layers less than 10^{-6} cm. thick. This mechanism is essentially a plastic flow within the boundary layer. The chief experimental data are described together with their technical implications.

The technological aspects of film lubrication are treated briefly and these remarks are made: (1) The equations developed indicate that low viscosity of the lubricant is desired. However, too low values are undesirable because such films might easily break down. (2) A further important requirement is chemical stability against oxidation, particularly at elevated temperatures prevalent in the bearings. The requirements under (1) and (2) have led to the preferential use of medium viscosity mineral oils as lubricants. (3) More specifically, the viscosity *v.* temperature curve should not be too steep in order not to obtain too low viscosities when the temperature rises. Spiers showed that temperatures in bearings increase rapidly with decreasing clearance, and that oil cooling has little value in reducing these temperatures. (4) Also the pressure variation of viscosity should be within certain limits. Muskat recently investigated this question as well, showing that the exponent in the exponential viscosity-pressure relation should not exceed the value 2. The limiting load, therefore, can be made higher, by selecting lubricants of relatively flat viscosity-pressure curves. Testing of oils for lubricants is very briefly indicated.

A mathematical theory of boundary lubrication does not yet exist, the whole field being still in the experimental stage. Bowden in a recent paper tried to show that the behaviour of such films is essentially controlled by their ability to withstand breakdown during sliding. It is important from a practical standpoint that small additions, say 1–2%, of fatty acids to mineral oil improve the lubricating property of the latter appreciably. In these cases the oil acts not only as a viscous film lubricant, but independently by way of adsorption to form stable boundary layers of the fatty acids. The result is that at higher pressures when the oil film becomes too thin to remain stable, the acid layer still remains intact and the viscous action of the oil is then simply replaced by a plastic flow of the acid. The technical aspects of boundary lubrication are discussed in a recent paper by Fogg (*J. Inst. Petrol.* (1940), (1), 1). Inorganic materials for boundary lubrication are discussed.

A. H. N.

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Geology and Development.

965. Resume of Oil-field Operations in 1939. R. D. Bush. *California Oil-fields*, **25**, July 1939—June 1940.—Total production of oil in the State of California for the year 1939 was 224,253,193 brl., as compared with a total of 249,398,399 brl. in 1938. Production for the second half of 1939 was 1,023,627 brl. more than for the first half.

According to statistics compiled by the American Petroleum Institute, total crude and refined petroleum in storage in Pacific Coast territory at the end of 1939 was 151,935,248 brl. Decrease in storage during the year was thus 5,749,041 brl., compared with an increase of 30,864,789 brl. during 1938. The total amount of crude and refined oil shipped to Atlantic Coast ports was 3,162,000 brl. more in 1939 than in 1938.

Two new fields, Strand and Paloma, were discovered during the year under review, and in addition new productive areas were developed in a number of fields, including West Montebello, Dominguez, Rosecrans, Wilmington, Torrance in Los Angeles County, and Trico Gas, Greeley, Coles Levee, Mountain View in Kern County.

Appended to the report are tables giving production by districts, and also statistics for each field regarding the average number of producing wells, number of barrels of oil recovered from each well, and amount of water produced. Similar tables are available for gas statistics during the year 1939. H. B. M.

966. West Montebello Oil-field and Application of the State Gas Law. H. P. Stolz. *California Oil-fields*, **25**, July 1939–June 1940.—West Montebello Oil-field lies to the north of the town of Montebello, and about 12 ml. east of Los Angeles, California. It is approximately 1½ ml. long and 1½ ml. wide. This report is the result of a study made by the author, who was consultant to some of the independent oil companies engaged in exploitation of the field.

Since the discovery in 1936 of West Montebello Field in the Second Zone of the "old" field (discovered in 1917) development has been progressive. As wells were deepened, new prolific oil and gas zones were discovered, and moreover, deeper productive sands not yet penetrated can be expected.

By January 1940, 160 wells were producing in the field and the total potential production was estimated at 83,700 brl. of oil per day. Total gas production at this time was over 97,000,000 cu. ft. per day, or an average gas ratio of over 4000 cu. ft. of gas per barrel of oil.

In January 1941, 189 wells were in production and the average daily yield of oil was 10,067 brl. Gas production amounted to an average of 57,834 mcf. per day, or an average gas–oil ratio of about 5700 cu. ft. per brl.

Total cumulative production to 1st October, 1941, amounted to 14,588,552 brl. of oil and 84,330,566 mcf. of gas. It is estimated that 21,647,500 mcf. of gas had been blown into the air up to that time.

Voluntary curtailment of production not having proved effective, the Attorney General's Office, on behalf of the Director of Natural Resources, brought an action in the Superior Court of Los Angeles County in May 1939. This resulted in the issue of a preliminary injunction in an attempt to restrain overproduction and waste of gas. The order was modified on several later occasions, but on the whole results obtained by the injunction suit were beneficial.

Conservation of gas energy led to a longer flowing life of individual wells, while savings in production costs increased the ultimate revenue. Operators in West Montebello Oil-field gradually learned the benefits to be derived by the conservation of gas energy. H. B. M.

967.* Canadian Output Outside Turner Valley Insignificant. Anon. *Oil Wkly*, 10.8.42, **106** (10), 46.—Only five fields in Western Canada, all located in Alberta, are producing fairly substantial amounts of crude apart from Turner Valley. Vermilion gave 5415

brl. of oil from ten small wells in May. The one well in the new Tilley field yielded 674 brl. during May, and the Plains 2 well at Taber produced 1032 brl. The five wells at Wainwright yielded 841 brl., and the seven wells at Red Coulee 872 brl. A little oil was obtained from the Terminal well at Del Bonita, and from wells at Dina, while occasionally the Princess field of British Columbia has been on production.

In May Turner Valley gave 866,675 brl. of oil, and the total for all the other fields was 10,057 brl. G. D. H.

968.* Two Good Wells at North Turner Valley. Anon. *Oil Wkly*, 10.8.42, **106** (10), 44.—Major 7 at North Turner Valley gave 2306 brl. of oil in 24 hr., and Foothills 10 1106 brl. in the same time. The former well is 3 ml. south-east of Atlas-British Dominion 2, the most northerly producer at Turner Valley. Foothills 10 is 8 ml. south-east of Atlas. G. D. H.

969.* Well Completion Rate Unchanged for Three Months. Anon. *Oil Wkly*, 10.8.42, **106** (10), 34.—During the past three months the number of well completions has varied only slightly from 56 per day. If this rate continues there will be about 21,000 completions this year.

1585 wells were completed during the four-week period ending 25th July, practically the same as the averages for May and June. 12,707 wells were completed during the first seven months of this year, a decrease of 26% compared with the same period of 1941. Increases occurred in Pennsylvania, West Virginia, New York, and New Mexico, but practically all other districts suffered declines, the worst being a decline of 46%.

Tables give data about the drilling operations in the different states and districts, and details about the types of completions for July 1942, the first seven months of 1942, June 1942, and July 1941. G. D. H.

970.* Recent Discoveries Increase Drilling in Jackson County. F. L. Singleton. *Oil Gas J.*, 20.8.42, **41** (15), 80.—An extensive wildcatting and development programme is under way in Jackson County on the Texas Gulf Coast, with the main activity about 4 ml. south-east and south-west of Ganado. Four new fields have been opened this year. The county now has fifteen producing fields, nine of them opened since 1939. This year's discoveries are Mayo, Harmon, West Mauritz, and Stewart, and they lie on a regional high extending east from Stewart to Mauritz. The oil accumulation is believed to be due to the wedging out of sands against this high. Mayo and Harmon may eventually be joined, although it is not certain that they are producing from the same reservoir.

The Mayo discovery well was brought in at 5408 ft. in the Frio, and gave 115 brl./day initially. Dry gas has been found below the producing sand, and there may be a gas-cap flanking the north edge of the structure. Three sands are productive in the Harmon field at 5375–5380 ft., 5385–5400 ft. and 5321–5329 ft. Production at West Mauritz is from 5447 to 5488 ft.

At Stewart production is from 4985 to 5000 ft., and the discovery well gave 700 brl./day initially. This field apparently has a gas-cap. The Ganado field is less than 2 ml. due east of Stewart, but it is probable that there is an intervening fault. Ganado has an oil sand at 5000–5100 ft., and others which are produced between 5500 and 6400 ft.

Twelve wildcats are planned in this region.

A map is appended. G. D. H.

971.* Typical Oil-Field Structures: Buried Sand Bar; Burbank Field, Osage County, Oklahoma. Anon. *Oil Gas J.*, 20.8.42, **41** (15), 54.—A series of sands and shales (Cherokee series) was deposited on the eroded Mississippi lime surface in a basin between the Ozark uplift on the east and the Central Kansas and Nemaha uplifts on the west. The west side of the basin was flat and shallow, and slight movements caused the shoreline to move backward and forward, with a gradual extension westward. In the east there are many producing sands, two of which, the Bartlesville and Burbank, form long, narrow lenses along definite trends. These lenses carry oil. The Teeter–Quincy trend and the Sallyards–Lamont trend have given important amounts of oil.

There is a regional dip of 30–40 ft./ml. with local undulations. Two undulations occur in the Burbank field, where the sand ranges from a feather edge to over 100 ft. in thickness. The sand bodies consist of a number of sand-bars formed on the western shore of the Pennsylvanian sea. The Burbank sand is not uniformly porous. It has a flat base and a convex top generally, and passes abruptly into shales. It is usually most porous where it is thickest. The contained oil is probably of local origin.

There are many fields associated with offshore or nearshore sand deposits.

Some claim that shoestring sands are reflected as minute detectable surface structural features. It is possible that large, shallow sand deposits could be located geophysically. Once the sand-strings are found, the following of certain trends may lead to further discoveries. Exploratory drilling following on the realization that the lenses are likely to be present seems to be the best method of locating them.

G. D. H.

972.* Smackover Lime Wedge-Edge Searched for Oil Deposits. R. Ingram. *Oil Gas J.*, 27.8.42, **41** (16), 76.—The Smackover lime has been shown to underlie most of the Tyler basin, and to carry oil when under suitable structural and textural conditions. The formation does not outcrop, and it produces no oil in Texas. The Tyler–Woodbine basin is bounded on the east by the Sabine uplift, on the west by the Bend Arch, and on the north by the Ouachitas. In the south it widens and dips towards the Gulf of Mexico.

During the early development of the basin, the Woodbine was the main objective, with deep exploration to the Paluxy, Glen Rose, and Rodessa. In 1936 large production was found in the Trinity group at Rodessa, and there were also Trinity discoveries at Talco, and a fault-line structure at the north end of the basin.

The Tyler basin has a neck which runs into south-west Arkansas, and there is also a sudden drop in the Palæozoic basement on an east–west line in Hempstead County. This condition seemed ideal for fault or shoreline oil trapping, and south of the break porous beds below the Trinity were found to pinch out before reaching the surface. This break is some miles north and west of the Mexia–Balcones fault system. In this region the Snow Hill pool in the upper Smackover lime was found in 1936, and the Schuler, Magnolia, Village, and Atlanta discoveries followed.

New conditions were found as exploration moved to the north edge of the neck of the basin where there is a graben. The first wells north of the fault found low permeability, and hopes fell. Evidence of the pinching out of the Smackover was found, and so, in addition to the search for structural traps, there was a search for true stratigraphic and possible shoreline traps.

In December 1941 the Midway Smackover pool was discovered north of the graben and on the north edge of that part of the basin. Midway is a structural trap. The Midway discovery led to extensive leasing along a 200-ml. line from Falls County, Texas, through Hunt County, and east to Arkansas. Some of the wildcats drilled as a consequence have found the Smackover lime, and one showed it to have good porosity and salt water, pointing to the possibility of production in suitable traps higher up.

There are possibilities of oil in the Marine group below the Smackover, and some entertain hopes of conglomerate production if eroded granite surfaces occur beyond the present limits of the Smackover and Eagle Mills. G. D. H.

973.* Summary of Operations, July. Anon. *Oil Gas J.*, 27.8.42, **41** (16), 99.—During the five-week period allotted to July the number of completions was considerably above that of the four-week period for June, but the weekly averages for the two periods were approximately 315 and 327 respectively. Exploratory work has been going on fairly steadily, and seems likely to increase in the next few months due to intensified wildcatting in Kansas, East, West and Coastal Texas, and North Louisiana. The number of completions in July 1942 was 50% below the figure for July 1941, and the percentage of oil-wells was 53 as compared with 69%.

A table gives details of the completions by States and districts. G. D. H.

974.* Three Starr County Discoveries Highlight Laredo District. F. L. Singleton. *Oil Gas J.*, 3.9.42, **41** (17), 57.—While there has been a large decrease in field development in the Laredo district during the first seven months of this year, wildcatting

was at the same level as during last year, and eight new fields have been opened, compared with two during the same period of last year. The development decline was due to various restrictions. Ninety-nine wildcats were drilled out of a total of 296 wells.

In Starr County three new Frio-Vicksburg sand-fields were opened, and the potentialities of proved fields along the same trend were enlarged. At North Sun oil was found at a depth of 5386–5389 ft. A second well found another sand at 4907–4914 ft., also in the Frio-Vicksburg. A third well has found a third sand at 4530–4533 ft. Although all the wells are considered to be on the same structure, there are dry wells between the producers.

The Frost field has a producing well yielding oil from 4184–4187 ft. The Garcia field in the extreme south of the county has two producers at a depth of about 3760 ft. The Sun field is now practically defined. It has eighty-two producers with a daily initial production of 1700 brl. The Rincon field now runs north-east–south-west for 5 ml.

In Hidalgo County two important gas-distillate reserves were added to the list of fields. These are Pentas and Donna near the Rio Grande river. Multiple sands have been logged in them, and there is the possibility of finding oil production down-dip, as has happened on other similar structures.

South-west of the old Bruni field the McLean field added a new deeper sand for the Jackson shoreline tend, and it is believed to be of upper Yegua age.

The Washburn field has six Wilcox producers, and has now been defined in the west and south-west. In the Green Branch area, McMullen County, a gas-well has been completed in the Wilcox at a depth of 5720 ft.

The 1942 discoveries in the Laredo district are tabulated, and a map shows the sites of the fields. G. D. H.

975.* Typical Oil-Field Structures; Monocline; Cabin Creek Field, Kanawha County, West Virginia. Anon. *Oil Gas J.*, 3.9.42, **41** (17), 32-B.—During early Mississippian time the whole of the Appalachian basin, which lies between the Appalachians and the Cincinnati geanticline, was not far from sea level, and lenticular sands were laid down in the eastern part, with irregular sands in Ohio. The basal sand is generally named the Berea, but all sands so named are not necessarily contemporaneous. A series of folds were formed parallel to the mountain trend.

Cabin Creek is on the flank of the Warfield anticline in a lenticular sand of Berea age. The sand contains no water, so that the oil occurs down the structure, with gas at the top of the lens. Elsewhere other sands act as oil reservoirs, and, excepting the Lower Devonian Oriskany sand, they tend to be older in Northern Pennsylvania than in South-west Pennsylvania and West Virginia, where they are of Mississippian and Pennsylvanian age. All are more or less lenticular and typical off-shore deposits.

A map, contour map, and cross-sections are included. G. D. H.

976.* Work Outside Turner Valley Aids Canadian Oil Outlook. J. L. Irwin. *Oil Gas J.*, 3.9.42, **41** (17), 25.—The Alberta oil production rose by 363,066 brl. in the first half of 1942 to give a total of 5,144,462 brl., 5,090,929 brl. being from Turner Valley. There has been a marked increase in the production from fields outside Turner Valley. Turner Valley has 190 producers, thirteen with allowables of over 400 brl./day, and the other fields have twenty-five producers. Vermilion is by far the best producer of the nine Alberta fields other than Turner Valley, and it gives 14–22° A.P.I. oil from the Lower Cretaceous at depths of 1600–1900 ft. Many of the Vermilion wells have to be pumped.

Ram River No. 2 has had a good oil-showing in the Devonian lime at a depth of 4300 ft., with indications of a 75-ft. porous zone. This well is 12 ml. south-east of No. 1, which met a major fault and was abandoned. No. 2 first had oil-showings at 4250 ft. In five days after closing in the casing pressure built up to 125 lb./in.^{2}, and finally it reached 165 lb./in.^{2}.

The monthly production is tabulated for Alberta as a whole, and the total production of each of the fields other than Turner Valley is listed for the first half of 1942. A map showing the well locations of Turner Valley is included. G. D. H.

Drilling.

977.* Steel Mud-Tanks Prove Practical in Many Areas. G. B. Nicholson. *Oil Wkly*, 3.8.42, **1106** (9), 33–36.—Details of such systems are described and illustrated photographically. In addition to fulfilling requirements where conditions of terrain obviate digging earthen pits for mud systems, steel tanks offer numerous advantages which, in the opinion of companies which advocate their use, may be summed up as follows: (1) Cost of tanks is not excessive, while construction considers mobility and durability to permit use over a long period. Digging and filling pits are eliminated, and setting-up and dismantling require little time. (2) Pump and equipment repairs and replacements are materially reduced by use of properly designed steel tanks, due largely to partial removal of abrasives from mud by means of baffles, and by maintaining positive hydrostatic head on suctions to assist pump action. (3) Small, compact but adequate systems forestall use of excessive mud, an economy amplified by flexible use of only portions of tanks which are needed for particular drilling conditions. Contamination is lessened, while loss due to seepage or breaks in dikes is averted by quick detection and repair. A further economy is realized by many oil companies which save mud in the systems and move it to the next location. (4) Mud engineers have facilities for accurately testing and treating muds, enabling them to conduct exact chemical treatments, and to maintain precise weight and viscosity. Positive tests may be made to determine exact characteristics of in-going mud, as well as variations in mud level in tanks, to determine proper input rate. A. H. N.

978. Patents on Drilling. J. C. Arnold. U.S.P. 2,288,876, 7.7.42. Appl. 21.1.41. Magnetic logging of well-bores characterized by rotating an inductor coil simultaneously about two axes at right angles to each other.

M. C. Bowsky. U.S.P. 2,288,884, 7.7.42. Appl. 11.12.39. Electrical logging in oil-filled wells.

J. Neufeld and E. H. Cooley. U.S.P. 2,288,973, 19.7.42. Appl. 15.12.39. Well-survey method and apparatus using electrical fields.

C. A. Shope. U.S.P. 2,289,217, 7.7.42. Appl. 16.4.41. Tubing rack for derricks affording free removal of tubing.

R. W. Stuart. U.S.P. 2,289,687, 14.7.42. Appl. 14.2.41. Method and apparatus for logging wells during drilling by measuring the electrical conductivity and hydrogen-ion concentration of the drilling fluid.

L. B. Hellman. U.S.P. 2,289,707, 14.7.42. Appl. 31.1.41. Drilling bit.

H. Dixon. U.S.P. 2,289,829, 14.7.42. Appl. 14.3.42. Fishing-tool shoe with V-shaped cutouts.

J. Neufeld. U.S.P. 2,289,926, 14.7.42. Appl. 18.3.40. Well-survey method and apparatus measuring radioactive radiations naturally emitted from formations traversed by a well-bore.

B. M. Scivally. U.S.P. 2,290,000, 14.7.42. Appl. 16.5.42. Pipe-cutter adapted to cut by rotation inside a pipe stuck in a well.

M. Schlumberger. U.S.P. 2,290,075, 14.7.42. Appl. 3.4.39. Thermal process and device for surveying the beds traversed by drill-holes by measuring the rate of heat transmission in these beds.

J. T. Hayward. U.S.P. 2,290,179, 21.7.42. Appl. 4.3.39. Method of detecting washouts in rotary well-drill strings by studying the stroke-cycle rate of the slush-pump.

C. W. Perkins. U.S.P. 2,290,247, 21.7.42. Appl. 20.6.41. Pipe-racker for operation on the platform of an oil-derrick.

W. J. Crites. U.S.P. 2,290,408, 21.7.42. Appl. 21.2.41. Exploration of boreholes by measuring and indicating the difference between the volume of fluid pumped into and out of the well.

J. Cuthill. U.S.P. 2,290,409, 21.7.42. Appl. 7.4.39. Means for withdrawing casing from wells or boreholes.

F. Squires. U.S.P. 2,290,502, 21.7.42. Appl. 29.12.38. Apparatus for forming subterranean cavities by a mechanical device.

C. W. Kinnear. U.S.P. 2,290,595, 21.7.42. Appl. 1.11.39. Rotary drill-bit with vertical cutting teeth.

W. Brauer. U.S.P. 2,290,735, 21.7.42. Appl. 20.3.39. Automatic cathead.

E. Gruenweld, H. R. Durbin and W. H. Tilley. U.S.P. 2,290,956, 28.7.42. Appl. 15.6.40. Retarding setting rate of Portland cement by incorporating 0·2 to 0·4% casein.

J. E. Ortloff. U.S.P. 2,291,055, 28.7.42. Appl. 2.4.42. Working platform for derrick masts.

W. N. Oswald. U.S.P. 2,291,100, 28.7.42. Appl. 5.7.40. Deflecting tool, including a knuckle joint.

M. E. Norris. U.S.P. 2,291,251, 28.7.42. Appl. 8.4.41. Drill-pipe protector remover and applicator.

J. W. Buchanan and C. C. Milligan. U.S.P. 2,291,371, 28.7.42. Appl. 3.8.40. Method and apparatus for cementing liners in wells.

R. T. Cloud. U.S.P. 2,291,692, 4.8.42. Appl. 2.6.38. Magnetic logging of geological formations traversed by a bore-hole.

W. J. Crites. U.S.P. 2,291,698, 4.8.42. Appl. 11.7.38. Temperature responsive means adapted for use under external pressure for imparting linear movements in response to temperature changes.

A. L. Lay and C. C. Farque. U.S.P. 2,291,732, 4.8.42. Appl. 26.4.40. Drilling rig comprising a portable rig, derrick, engine, hydraulic transmission and gear-operated drill revolving means.

G. E. Behnke. U.S.P. 2,292,036, 4.8.42. Appl. 28.6.40. Bearing for drill-bits using cone-cutters.

E. W. Isley. U.S.P. 2,292,126, 4.8.42. Appl. 8.4.39. Well-drilling apparatus, including a drill unit of the advancing motor type and means for using sludge-water around the motor-housing.

A. D. Garrison. U.S.P. 2,292,267, 4.8.42. Appl. 7.7.37. Preparation of drilling muds of special viscosity characteristics attained by use of additives.

A. L. Gibbons and H. H. Harrison. U.S.P. 2,292,268, 4.8.42. Appl. 6.3.39. Well-straightening device.

T. J. Crawford. U.S.P. 2,292,363, 11.8.42. Appl. 18.8.41. Method of treating oil-well casing thermally to certain temperatures depending on their diameter to thickness ratios.

A. R. Maier. U.S.P. 2,292,457, 11.8.42. Appl. 14.8.41. Travelling block.

C. T. O'Connor. U.S.P. 2,292,711, 11.8.42. Appl. 22.1.41. Wire-line socket and tool-latch.

P. H. Jones. U.S.P. 2,292,838, 11.8.42. Appl. 6.12.38. Method and apparatus for imparting directional magnetic properties to core-samples.

C. L. Charles. U.S.P. 2,292,867, 11.8.42. Appl. 15.1.40. Drilling apparatus of the portable percussive type.

A. S. Rairden. U.S.P. 2,292,971, 11.8.42. Appl. 12.6.40. Well-cable tool-drilling line and method of making same.

C. D. Johnson. U.S.P. 2,293,259, 18.8.42. Appl. 25.3.41. Device for preventing clogging of drilling bits.

A. H. Brunberg. U.S.P. 2,293,380, 18.8.42. Appl. 14.3.41. Safety platform for oil-well derricks.

L. E. Mathews. U.S.P. 2,293,396, 18.8.42. Appl. 5.10.40. Derrick drill of the portable type.

W. C. Francis. U.S.P. 2,293,603, 18.8.42. Appl. 3.3.41. Roller bit with the cutters on ball and roller bearings.

R. S. Kail. U.S.P. 2,293,904, 25.8.42. Appl. 22.9.39. Method of batch cementing of a porous formation in a well.

H. J. Woolslayer, E. A. Campbell, and C. Jenkins. U.S.P. 2,293,958, 25.8.42. Appl. 11.8.41. Narrow bottom tiltable mast for oil-well derrick structure.

R. Neuhaus. U.S.P. 2,293,997, 25.8.42. Appl. 1.8.39. Method of making tool-joints.

E. S. Long. U.S.P. 2,294,506, 1.9.42. Appl. 5.7.40. Drill-pipe protector and tool therefor.

H. V. Steadman and E. E. Davis. U.S.P. 2,294,521, 1.9.42. Appl. 24.6.41. Removable plug for drilling strings to be used in coring operations.

L. E. Garfield. U.S.P. 2,294,544, 1.9.42. Appl. 15.8.40. Cutter teeth for well-drills, the outward and inward sides of which are more abrasive resistant than the rest.

C. E. Reed. U.S.P. 2,294,629, 1.9.42. Appl. 26.2.40. Earth-boring tool.

T. B. Wayne. U.S.P. 2,294,877, 1.9.42. Appl. 5.9.41. Treatment of drilling fluid with a small percentage of a water-soluble polyphosphoric acid compound.

M. Williams. U.S.P. 2,294,067, 8.9.42. Appl. 16.10.37. Drilling mud composition of an aqueous slurry of clay containing saccharic acid.

S. W. Mims. U.S.P. 2,295,418, 8.9.42. Appl. 30.11.39. Apparatus for well cementing. A. H. N.

Production.

979.* Predetermining Results of Secondary Recovery Methods. W. L. Horner. *Oil Wkly*, 3.8.42, **106** (9), 22.—It is emphasized that secondary recovery methods which prove successful in one field may fail in another and *vice versa*. Water-flooding is discussed in some detail. It is maintained that, provided certain tests are performed and data are collected and studied, predictable results can be made. The problems in water-flooding vary with every property and every well. The correct solution of the problems depends on depth of sand, sand thickness, and porosity and permeability of the sand. Correct consideration of those factors determines the well-spacing best suited to the property, the amount of water the intake wells should receive before oil-wells are drilled, pressure to be used, and property equipment—whether pumping or flowing. The present system of calculating the quantitative oil universally recoverable by water-flooding was developed at Bradford in 1933. Prior to that time recovery was approximately foretold by using cores to determine the amount of oil in place, then multiplying that amount of oil by a fixed fraction which

was an experience factor. Whereas oil recoverable by gas expansion and by gas injection may be expressed as a part of the pore volume, water-drive yields are also modified by two factors which can be measured—connate water and residual oil content. The term residual oil content refers to oil left in place after water-drive. Since these factors can be determined directly, and recoverable oil content can be calculated with greater accuracy by using them, there is no necessity for the use of empirical means. Successful predictions now require more accurate measurements of porosity than obtainable through the conventional methods. Measurements of connate water content, shrinkage, reservoir pressures, and residual oil content are also required.

It has been observed that in many cases the practice of injecting gas has increased the rate of recovery from oil reservoirs. During recent years production curves from a large number of fields have been published in which it is typically shown that production decline was arrested by this means of secondary recovery. However, in many such cases unbiased investigation of underground conditions shows that natural water-drive has often been an unrecognized factor and was responsible for much of the additional recovery which has been credited to gas injection. During recent years laboratory investigations have disclosed the mechanisms which control the decline of rate of oil movement and the relative increase in flow of gas which results from depletion of the reservoir. By applying these principles to facts measurable through analysis of cores and reservoir fluids, past performances have been reliably reconstructed, and it is believed that proper use of this technique is an acceptable basis for the prediction of future behaviour of pressures and gas–oil ratio in any given field during production by natural means, water drive or with gas injection. It is observed that under either method of secondary recovery the amount of gas produced/brl. of oil does not exceed the amount dissolved until a substantial portion of the recoverable oil has been produced. A. H. N.

980. Development, Operation and Valuation of Oil and Gas Properties. Part 11. P. J. Jones. *Oil Gas J.*, 6.8.42, **41** (13), 39–40.—This part of the paper is a continuation of Part 10 in particular. Producing efficiencies are discussed, together with formulæ for their calculation. Production under partial water-drive is analyzed briefly. A. H. N.

981. New-Type Multiple Completion Technique Developed in Illinois. H. F. Simons. *Oil Gas J.*, 6.8.42, **41** (13), 31–32.—Normally, the multizone-completion method used has been one of the following: (1) The use of a removable section in the casing string, opposite the upper pay-zone or zones. These removable sections were cut out after the lower zone had been completed and tested. Generally this removable section was either aluminium-alloy pipe which could be cut out, eaten out with acid, or shot out with explosives. (2) The use of black merchant pipe opposite the upper horizons. Here again this section was removed with an expanding tool (either a wall scraper or a mill), after the lower zone was completed. (3) Some operators used the regular casing string, later removing the portion opposite the upper pay-zone with an expanding tool, an expanding mill, or a whipstock.

The new method does not use a removable section and does not require a mill to cut out the pipe opposite the upper pay-zones. Actually it is a succession of liners, or a succession of casing sections, run in the well with the portion of the hole opposite the upper pay-zones being left uncased. The procedure, when completing in three zones, is to run either a slotted or blank section of pipe opposite the lower zone and up to the base of the next higher pay. This liner is run on the tubing and is cemented in place. The second liner is run on the tubing and cemented in the hole above the second lowest pay-zone and extends to the base of the third and highest pay-formation; this liner is, of course, run in on the tubing. The remainder of the casing string is then run to the desired depth and cemented in the regular manner. Each of the zones can be shot, cleaned out, and produced.

Repair work and certain details of multiple completion jobs are given.
A. H. N.

982. Automatic Discharge from Salt-Water Pits in the East Texas Field. Anon. *Oil Gas J.*, 13.8.42, **41** (14), 42.—The automatic discharge is accomplished by a pick-

up pump at a salt-water pit with an automatic starter and shut off. A float is hung on a chain inside a vertical concrete pipe. The chain passes over a small wheel, and a lead weight is attached to its other end, hanging outside the pipe. The small wheel is on the switch-box of the pump-motor, and immediately beneath it is a lever which is forked at both ends. Stops are placed on the chain at the desired points, and these engage the lever, thereby providing a means of tripping the switch to start and stop the motor. The vertical concrete pipe is open at the bottom so that its water level will be the same as that of the pit. When the water reaches a certain level the motor is turned on and it runs until the water has been drawn down to a predetermined level. Discharge from the pick-up pump goes to a water-disposal well located outside the limits of the field. Other details are given. A. H. N.

983. Strong Acid Gives Encouraging Results in West Texas Wells. H. F. Simons. *Oil Gas J.*, 13.8.42, **41** (14), 37–38.—The primary reasons for increasing the strength of the acid used are: (1) a reduction in costs, (2) a greater increase in production of the well, and (3) less clean-out time after acidization. Actually there is a considerable number of phenomena concerned with the use of stronger acids not easily explained. One of the reasons for not using the heavier acids originally was the fear of plugging the formation, due to the sludge produced through the reaction of the acid with the limestone. The 15% acid is also slightly less viscous and has a lesser tendency to emulsification. Testing of a sample of the formation with a stronger acid will determine, in many instances, whether an adverse effect would be produced. The use of acid stronger than 25% is impracticable because of the difficulty of inhibiting the stronger acids.

From a table it is seen that the swabbing time after using 20% averaged 13·9 hr., while swabbing time following the use of 15% acid averaged 21·1 hr. The amount of fluid swabbed was less when 20% acid was used. The number of hours flowed, after acidizing the well, was 16·8 in the case of 20% acid and 36·1% in the case of the 15% acid; volume flowed was 297·3 brl. for the 20% acid and 233 brl. for the 15% acid. The comparison is even more outstanding when it is seen that the brl./hr. is 17·6 with the stronger acid and 6·4 with the standard 15% solution.

When using 15% acid, it was noted that slugs of spent acid would be produced, after which clean oil would be brought to the surface for a while and then another slug produced. The swabbing or flowing of the well would have to be continued for some time before it was certain that all the spent acid had been removed from the hole. It has been noticed that when using the 20% or 25% acid, all the spent acid is recovered, after which the well begins making clean oil. For this reason alone, the time spent in cleaning out after acidizing is considerably reduced. Theories for explaining this phenomenon are given briefly. A. H. N.

984.* Low-Cost Heater Solves Freezing on High-Pressure Wells. G. M. Wilson. *Oil Wkly*, 17.8.42, **106** (11), 26.—Reduction of flow-pressure from 3300 lb. down to a 550-lb.-gathering-system pressure was causing the flow manifold to freeze up, due to expansion of gas-distillate production. Collection of ice made it difficult to operate manifold valves, and often caused a stoppage of flow into the gathering system. Freezing would occur at elbows where danger of bursting was more acute.

Solution to the problem lay in installation of some sort of hot-water or steam-jacket that would hold the flow-line temperatures above freezing. Such a system, however, had to be simple and sufficiently automatic in operation to permit its being left unattended for perhaps several days at a time, since the wells are widely spaced and are some distance from field headquarters. It was finally decided to use a small gas-fired water heater, set up at some distance from the well, which would circulate water through an insulated jacket welded to the flow manifold, then return to the heater to be reheated.

The heater is of the type commonly used in apartment houses and industrial plants. It is known as the "booster type," which in this particular size has a storage capacity of only 18–20 gal. It is not intended to store heated water; instead it is designed to heat up quickly and send it out into the circulating system. It will give up approximately 115,500 b.t.u./hr., and can heat 160 gal. of water/hr. A moderate temperature is maintained, and it can be adjusted to any point which

suits the flow conditions of any particular well. The unit has a 150-lb. working pressure capacity. The heater and the mode of its use are described with illustrations.
A. H. N.

985.* Plugging Air Channels with Floating Sand. F. R. Cossens. *Oil Wkly*, 17.8.42, **106** (11), 33.—The sand-plugging procedure is generally carried out by releasing the air pressure on a badly channelled intake well, and pulling any packers which may have been seated in the sand. Fresh, crude oil, into which has been vigorously stirred floating sand (proportions being 1 measured gal. of floating sand in normal pasty form, to each 50 gal. of oil), is introduced into the well until the chamber at the bottom is filled. Connections are replaced at the casing head, and air from the compressor unit is forced into the well until sufficient pressure has accumulated to force the oil and sand residue back into the sand body. Length of time and amount of pressure required for the task depend on conditions existing in the sand area. One to three days of continuous forcing, at a built-up air pressure of 100–300 lb., are the average ratio for most districts. After fluid and plugging residue has been thoroughly forced into the sand, the air pressure is released at the casing-head, and the chamber is re-filled with clean oil. Pumping equipment is next installed with necessary connections so that the well can be circulated freely for 24–36 hr., then pumped dry. Oil circulated by the pump washes the face of the chamber free of floating sand which has accumulated upon it during the forcing process, but greater quantities have normally been pushed back into the larger sand-channels where the material remains untouched by the reservoir washing.
A. H. N.

986.* Special Bottom-Hole Pressure Truck has Advantages. J. C. Albright. *Oil Wkly*, 17.8.42, **106** (11), 30.—The unit is used to test over forty producing wells frequently to determine reservoir conditions. The complete unit consists of a light truck on to which has been placed a special body fitted with trays, bins and drawers for tools and spare parts, plus all necessary equipment for testing and determining bottom-hole pressures. Included in the equipment is a self-contained mast, thus eliminating the need for individual masts or tripods at each well, and thereby releasing material that can be used elsewhere. Also included is the equipment necessary for testing and checking the indicating pressure gauges.

The mast is carried on a heavy steel supporting member bolted securely to the back of the chassis frame sills and resting on the rear bumper for additional support. The supporting member is massive enough for the truck to be driven over rugged terrain with the mast raised without danger of side-sway or tipping.

The hoist and the method of working it are described in detail and illustrated.
A. H. N.

987*. Truck-Mounted Steam Cleaning Unit Performs Many Jobs. E. Sterrett. *Oil Wkly*, 17.8.42, **106** (11), 17.—A unit having a steam-generating coil similar to those used on Diesel-powered trains for heating passenger compartments is described. Tank-cleaning may be done with steam alone, steam from the generating unit being carried to the job in a standard steam hose or through combination of flexible piping and hose, and directed against the surfaces to be cleaned. This method relies largely on the dual blasting and heating effects of the steam to remove the loosened dirt, and is not as satisfactory as the one usually followed, in which steam from the generating coils is mixed with water, so as to make the resultant steam as wet as possible. This reduction of steam temperature guards against blistering of tank-paint, and also provides sufficient condensation flow, as the relatively cold tank metal is contacted to form a flushing film which aids greatly in removing the waste and dirt without spattering it over adjoining structures.

If further refinement of the cleaning is desired, the stream added to the steam-flow may carry cleaning compound of any desired strength, the cleaner being added in the drum or other mixing vat and picked up in solution from that point by the suction hose from that end of the unit pump transferring the mixture into the flow-line to the washing nozzles. A few details are included.

Tubing pulled from a well being serviced is frequently found to be so clogged with paraffin, especially through certain zones of the well depth, as to require thorough

cleaning before returning to the well. Where such tubing is to be steamed out, the operation is speeded up and removal made more complete if the tubing be stacked with the end away from the well a foot or so lower than the other, and with the random lengths taken care of at the lower end. Close ranking of the tubing at the high end reduces the labour of switching the steam nozzle and enables a check on finished work to be kept without markers or other aids. The steam generator is set up as for tank-cleaning, except that the dilution stream pumped into the steam is pure water only, to give as great a volume of flushing fluid as possible after the heat in the steam has liquefied the paraffin. The nozzle used is different from that used for tank-cleaning. Details are given.

Cleaning surface lines is also extensively described. The unit is described in detail at the end of the paper. Safeguards are built into the unit which automatically cut off the fire and stop the operating motor if the water pressure becomes too low, if the fuel flow is stopped, or if the temperatures passed a predetermined maximum. Since the blower fan is started at the same time that the magneto is set in operation, accumulation of gases within the generator housing to the point where an explosion might occur is prevented and the space ventilated adequately. Pressure-actuated devices cut off the fuel unless the boiler is filled and either water or steam pressure maintained at the desired setting, it being necessary to fill the tubes with water by a hand pump before starting the operating engine; otherwise the unit would cut off and remain inactive, thus preventing the tubes from being burnt out by being fired when dry.

A. H. N.

988.* Weak Acid Gives Good Results in North Central Texas Wells. Part 2. H. F. Simons. *Oil Gas J.*, 27.8.42, **41** (16), 37–38.—Part 1 of this paper discussed the use of 20% acid in New Mexico and West Texas, where the normally used inhibited 15% hydrochloric acid was ineffective. This part deals with using a weaker acid than the usual 15% where this acid failed. A 10% acid is studied, as it produced better results in one particular field than the 15% acid. The exact explanation for the better success of the weaker acid is not forthcoming, and its value can best be judged on the results. There are several factors which might contribute to the success of the 10% acid. The weaker acid solution is less viscous and produces a less viscous spent acid. It is therefore less likely to emulsify. The weaker acid has a very good non-emulsifying characteristic and, as might be expected, has lower surface tension. However, non-emulsifying agents and surface-tension-reduction agents have been added to the weaker acid to increase these qualities. Another factor which may be important is the small amount of soluble material in the formation. The inhibition of the acid against steel corrosion is no problem.

Comparative study of the two strengths is made. Wells in the area are all on the pump, and are acidized with the tubing in the well. One method is to pull the rods and leave the standing valve in place and load the tubing with oil. The acid is then put in the casing and followed with oil from the stock-tanks. The acid is left on the formation for about an hour, after which it is pumped out through the tubing. Another method is to fill the hole with oil and pull the standing valve. The acid is then put down through the tubing and allowed to stand on the formation approximately as before. In the meantime the rods are run in the well, preparatory to pumping out the acid and load oil.

Formulæ are given for diluting the strong acid. As the amount of soluble material in the formation is reduced (the average calcium carbonate in the KMA "sand" is 15-35%), less acid is required to remove the material and open the pores in a given volume of the formation. In a case where the well is shot and the contact area quite great, penetration of the 10% acid is sufficient to open drainage channels that are rather extensive. It is shown that a little over 7 cu. ft. of pure limestone is dissolved by 1000 gal. of the 10% acid, which means that when the formation contains only 15-35% calcium carbonate, 45-5 cu. ft. of the formation will react with the acid. The problem thus becomes one of forcing the weak acid into the formation to contact the greatest volume of soluble material. The average treatment of 3000 gal. of 10% acid results in the removal of calcium carbonate from 136-5 cu. ft. of formation. The lack of complete success of the stronger acid may, in part, be due to a Jamin effect caused by its higher surface tension.

A. H. N.

900. Patents on Production. A. Boynton. U.S.P. 2,288,605, 7.7.42. Appl. 8.12.39. Differential flow-device with valve-controlling means, for the gas-lifting of liquids from wells through a tubing.

J. P. Bradner. U.S.P. 2,288,780, 7.7.42. Appl. 21.2.40. Packer of the conical type which is used in formation testing by seating it against a shoulder in the well-bore.

A. J. Zschokke. U.S.P. 2,288,931, 7.7.42. Appl. 1.8.41. Gun perforator with laterally directed gun-bores spaced at different angles and interconnected.

A. J. Zschokke. U.S.P. 2,288,932, 7.7.42. Appl. 4.8.41. Gun perforator with multiple bores and a central cartridge bore.

A. L. Parker. U.S.P. 2,289,382, 14.7.42. Appl. 7.11.40. Tube coupling.

L. Yost. U.S.P. 2,289,401, 14.7.42. Appl. 24.3.41. Submersible pumping unit for deep wells.

L. M. Trawick. U.S.P. 2,289,603, 14.7.42. Appl. 3.9.40. Well-flowing apparatus containing a choke made of tubing and collars.

J. F. Cailloux. U.S.P. 2,289,696, 14.7.42. Appl. 28.10.40. Tubing head comprising a soft deformable support.

L. C. Chamberlain and O. E. Barstow. U.S.P. 2,289,755, 14.7.42. Appl. 28.8.40. Apparatus for treating wells by simultaneously injecting fluid into at least two zones traversed by the bore.

J. N. Gilman and G. S. Giveen. U.S.P. 2,289,772, 14.7.42. Appl. 9.3.40. Convertible pumping system adaptable for operation as a high- or low-pressure system and using centrifugal pump.

J. W. Johnson. U.S.P. 2,290,127, 4.7.42. Appl. 31.1.40. Sand and gas excluder means for wells.

C. E. Burt. U.S.P. 2,290,141, 14.7.42. Appl. 14.1.39. Perforation cleaning method and apparatus using a packer above the screen and injecting fluid above the packer to create suction through the perforations.

C. E. Burt. U.S.P. 2,290,142, 14.7.42. Appl. 23.12.39. Retrievable well-packer with a body adapted for attachment to a tubular string for passage through a well-casing.

C. M. Blair, Jr. U.S.P. 2,290,154, 21.7.42. Appl. 27.6.40. Process for breaking petroleum emulsions of the water-in-oil type using a demulsifier from a general class of compounds.

A. Parmeson. U.S.P. 2,290,351, 21.7.42. Appl. 23.2.38. Swab for wells comprising a mandrel and divided sealing means on the mandrel.

M. De Groote and B. Keiser. U.S.P. 2,290,411, 21.7.42. Appl. 27.6.40. Process for breaking petroleum emulsions of the water-in-oil type by means of a demulsifier from a general class of diamines.

M. De Groote. U.S.P. 2,290,413, 21.7.42. Appl. 11.10.40. Composition of matter and process for preventing water-in-oil type emulsions resulting from acidization of calcareous oil-bearing strata.

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M. De Groote. U.S.P. 2,290,415, 21.7.42. Appl. 11.10.40. Composition of matter and provcess for preenting water-in-oil type emulsions resulting from acidization of calcareous oil-bearing strata.

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J. M. Courtney. U.S.P. 2,291,378, 28.7.42. Appl. 27.5.41. Well-pumping apparatus using a reciprocating pump.

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K. Kelley. U.S.P. 2,291,902, 4.8.42. Appl. 8.4.40. Gas anchor in combination with a string of tubing.

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M. De Groote and B. Keiser. U.S.P. 2,295,163, 8.9.42. Appl. 21.3.41. Process for breaking petroleum emulsions of the water-in-oil type using a water-soluble esterification product.

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M. De Groote and B. Keiser. U.S.P. 2,295,167, 8.9.42. Appl. 21.3.41. Process for breaking petroleum emulsions of the water-in-oil type using a water-soluble esterification product.

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A. H. N.

Transport and Storage.

990.* Recent Developments in Cathodic Protection of Bare Pipe-Lines. G. R. Olson. *Petrol. Engr*, May 1942, **13** (8), 35.—Little information is available regarding relative costs of protection of pipe-line afforded by cathodic protection alone, or combined with varying degrees of coating, over long periods of operation. A description is given of a method of cathodic protection applied to short sections of old bare lines which had become so seriously corroded that reconditioning or replacement would otherwise have been necessary within a few years.

An electric power-line carrying single high-voltage and low-voltage conductors was built parallel to the pipe-line. At suitable intervals transformers were installed to step down the supply voltage from 2300 to 110 volts, and each pole was fitted with a small rectifier unit of special design to permit easy adjustment of output ratings to suit field requirements under service conditions. An anode of scrap pipe was installed near the base of the pole, and the pipe-line used as common return for both circuits. Pipe to soil potential measurements are used as a guide in adjusting unit outputs, but subsequent changes are frequently necessary as a result of experience or change in conditions. Two installations covering respectively 20·9 and 4·8 m. sections of bare pipe were placed in service early in 1941, and tables and graphs give details of the section of line protected, cathodic protection requirements, overall efficiency of the installations, and measurements of soil resistivity and pipe to copper sulphate plug potentials along the line. Subsequently other sections of pipe, some bare and others poorly coated, have been protected by similar installations, and details are given. Current densities required for protection of sections of bare pipe vary from below 1 to over 6 expressed in milliamps per sq. ft. of pipe surface exposed, and requirement does not appear to correlate with other available data. The average current density of the two initial lines varies from 2·2 to 2·9 milliamps. per sq. ft. of pipe surface exposed. Records show the greatly reduced frequency of corrosion leaks resulting from the protection applied. Ten poles per mile run of pipe was used for the initial scheme, but pole spacing will depend on whether the pipe is bare or coated and relative costs of equipment required. Improvements in ground anodes are desirable, and experiments are in hand with this object in view. Estimates are given of savings in future steel requirements as a result of the installation concerned. R. A. E.

Gas.

991.* Natural Gas—An Important Factor in California's Economy. W. A. Sawdon. *Petrol. Engr*, July 1942, **13** (11), 80.—California has a greater number of natural gas consumers than any other State in the U.S.A., is second in natural gas sales and is the only large producing State that neither imports nor exports natural gas. The State is almost dependant on natural gas for heating, and industry relies largely on it for fuel. Until recently there was more than enough gas from oil-wells to meet demand, and little dry gas was taken from gas-fields even during peak loads. Tables and graphs show the total production of casing-head and dry gases and their utilization for the period 1923–41. The percentage of unconserved gas has been greatly reduced in recent years, and in 1941 amounted to only 3·6. Control of gas–oil ratios in the production of oil-wells and the possible effect on gas production of a change in product demand are factors which necessitate increased attention being paid to gas supplies from natural gas-wells. In 1941 such gas represented about 9% of total production. The number of producing wells is 110, mainly situated in the Rio Vista field and serving the San Francisco Bay area. This has rendered possible the release of a large gas-line from the south to transport oil to refineries. Additional gas-wells are being drilled. R. A. E.

992.* Natural Gas—Possibilities of Exploitation in Great Britain. L. Ivanovsky. *Petroleum*, August 1942, **5** (8), 133.—The production of synthetic fuel from natural gas sources presents obvious advantages at a time when coal is in short supply. In an appendix, the process for converting natural gas into water gas and hydrogen

with the aid of steam and suitable catalysts, referred to in Technical Paper 622 of the Bureau of Mines, is described. This process could be modified to provide a suitable "synthesis gas" which could be used as raw material for Fischer–Tropsch or Robinson–Bindley processes. This would simplify the processes and possibly offer economic advantages. Little information is available in regard to the potential supplies of natural gas in the U.K., but according to a report of 1938 a group of Scottish gas-wells could supply over 10 million cu. ft. of gas per day, although sealed at that time. They appear to provide the most important source of natural gas in this country. In addition, supplies of methane could be obtained from coal-mines, coal and coke-oven gases, and sewage works. Extracts from the *Bulletin of the Imperial Institute* dealing with the natural gas situation in Great Britain are given in the Appendix. R. A. E.

Polymerization and Alkylation.

993. Patents in Polymerization and Alkylation. Anglo-Iranian Oil Co. E.P. 546,037, 24.6.42. Appl. 23.12.40.—Process for the polymerization of olefines, especially normally gaseous olefines, for the production of motor spirit or a blending material for same. During the operation a solid phosphoric acid catalyst composed of *ortho*-phosphoric acid, copper *ortho*-phosphate, and calcium *ortho*-phosphate is used. The ratio of *ortho*-phosphoric acid to copper *ortho*-phosphate and calcium *ortho*-phosphate in the catalyst is greater than 4 : 1 : 1, but not substantially greater than 8 : 1 : 1.

Standard Oil Development Co. E.P. 546,334, 8.7.42. Appl. 10.7.40.—Method of converting *iso*paraffinic hydrocarbons into hydrocarbons of higher molecular weight by reaction with normally gaseous olefines. The reaction is effected in the presence of a catalyst consisting of a product formed by the reaction of a saturated normally liquid hydrocarbon and aluminium chloride or aluminium bromide.

Texaco Development Corp. E.P. 547,214, 19.8.42. Appl. 7.5.40.—Process for the production of high anti-knock hydrocarbons suitable for motor fuel by alkylating a low-boiling *iso*paraffin with C_3 and C_4 olefins.

W. E. Bradley and K. J. Korpi. U.S.P. 2,286,183, 16.6.42. Appl. 2.5.38.—Production of motor fuels by reacting *iso*paraffinic hydrocarbons of less than seven carbon atoms per molecule with olefinic hydrocarbons having more than two carbon atoms per molecule, in the presence of an alkylating catalyst and diamyl ether.

W. E. Bradley and K. J. Korpi. U.S.P. 2,286,184, 16.6.42. Appl. 14.5.38.—Process of forming alkylated paraffinic hydrocarbons by reacting *iso*paraffinic hydrocarbons of less than seven carbon atoms per molecule with olefinic hydrocarbons having more than two carbon atoms per molecule in the presence of strong sulphuric acid and a low-molecular-weight carboxylic acid.

F. D. Parker. U.S.P. 2,286,504, 16.6.42. Appl. 30.1.39.—Production of branched-chain saturated hydrocarbons boiling within the gasoline range. *iso*Paraffinic hydrocarbons are reacted with normally gaseous olefinic hydrocarbons in the presence of an alkylating catalyst. The process is characterized by contacting the gaseous olefins with a hydrocarbon liquid absorbing medium prior to contact with the *iso*paraffin and alkylating catalyst. In this way is produced a liquid mixture containing absorbed olefins, which is in turn mixed with liquefied *iso*paraffins and catalyst.

H. Heinemann. U.S.P. 2,286,543, 16.6.42. Appl. 10.7.41.—Alkylation of *iso*paraffins with olefins which involves reacting an *iso*paraffin with an olefin at a temperature between 300° and 500° F. under a pressure of 300–450 lb. per sq. in. in the presence of a catalytic composition containing a metal halide selected from the group consisting of zinc halides, aluminium halides, ferric halides, and stannic halides, in admixture with an oxygen containing compound of antimony. H. B. M.

Synthetic Products.

994.* Synthesis of Known Hydrocarbons in Petroleum. W. L. Faith. *Petrol. Engr*, May 1942, **13** (8), 96.—In view of the increasing importance attached to the preparation of individual hydrocarbons from petroleum, the most satisfactory methods of synthesizing various hydrocarbons known to be present in petroleum are reviewed.

The most common methods of synthesizing paraffinic hydrocarbons are: (1) Wurtz reaction, (2) Clemmensen reaction, (3) Grignard reaction, (4) electrolytic reduction of ketones and esters, (5) catalytic hydrogenation of olefines which may be prepared by dehydration of alcohols. The proper method to choose for a particular hydrocarbon depends on several factors, including availability of raw materials, but purification of products at each step and efficient fractionation in the final step are of utmost importance. Twenty-eight paraffinic hydrocarbons have already been isolated by Rossini of the Bureau of Standards from fractions of Mid-Continent crude.

Methane, ethane, and propane can be prepared in large quantities by fractionation of natural and cracking still gases. Twenty-two of the other paraffins can be prepared by method (5), which is generally preferred and is more adaptable to large-scale manufacture. Details are given of the starting alcohol and intermediate olefin in each preparation, with references to literature giving requisite details of process. 3-Methyloctane has been made by Grignard synthesis and *n*-decane and *n*-dodecane by Wurtz synthesis. Present commercial production of paraffinic hydrocarbons and future possibilities are discussed.

Twelve different naphthenic hydrocarbons have been isolated by Rossini from petroleum fractions. The most suitable method of preparation of the majority of these is catalytic hydrogenation of the corresponding aromatic hydrocarbon. This may be carried out at room temperature and slightly elevated pressures using a platinum oxide plus platinum-black catalyst, or at higher temperatures and pressures using a nickel catalyst. A list is given of eight naphthenic hydrocarbons prepared by catalytic hydrogenation, showing raw material, catalyst used, and literature reference. The remaining four naphthenes have been prepared from the corresponding alcohol by similar methods as are applied in the case of paraffinic hydrocarbons. The lower naphthene hydrocarbons are already being produced commercially, and the catalytic hydrogenation method is readily adaptable to large-scale manufacture given pure raw materials. Future possibilities are discussed.

Twenty-one aromatic hydrocarbons have been isolated by Rossini from petroleum. These may be prepared by a wider variety of reactions than either paraffin or naphthene hydrocarbons, but the choice of the particular combination to use in a given case is a matter of experience. As examples, methods often applied are: (1) Friedel and Crafts reaction, alkyl halide condensed with a benzene compound in the presence of $AlCl_3$, (2) reaction of benzene with alcohols, esters, ethers, olefines, and naphthenes in the presence of a condensing agent such as BF_3, H_2F_2, and H_2SO_4. Suitable methods of preparing various benzene and naphthalene hydrocarbons are listed with appropriate references. The manufacture of benzene hydrocarbons by cyclization of *n*-paraffin hydrocarbons is also mentioned. R. A. E.

995.* Synthetic Rubbers to Meet Requirements of Natural Rubber in Industry. C. C. Pryor. *Petrol. Engr*, May 1942, **13** (8), 127.—The article traces the history of rubber synthesis and describes the reactions involved in the manufacture of Buna S, Buna N, Neoprene, Butyl rubber, Ameripol, Chemigums, Thiokols and Vistanex. The properties and applications of these synthetic materials are also described, and production figures for the U.S. during the three years 1939/1941 are given. R. A. E.

996. Synthetic Drying Oils. Anon. *Chem. Tr. J.*, 21.8.42, 111, 179.—E.P. 545,765 of 1941 granted to E. I. du Pont de Nemours & Co. describes the production of synthetic drying oils by the polymerization of butadiene and its homologues. Previous methods of polymerizing unsaturated hydrocarbons have given low yields of products, inferior in drying characteristics to natural drying oils. In the present invention butadiene or its homologues are subjected to high temperatures and pressures in the presence of (*a*) 3-6% of a promoter consisting of an aldehyde, preferably *n*-butyraldehyde, or a ketone, (*b*) a catalyst consisting of a copper salt of an organic or other weak acid, *e.g.*, cupric acetate, and (*c*) 10% to 30% of a hydrocarbon solvent, *e.g.*, benzene. Smaller quantities of promoter give low yield of drying oil and higher quantities produce rubbery materials. An example is given of a mixture of 80 parts of butadiene, 17 parts benzene, 3 parts *n*-butyraldehyde, 12 parts of catalyst mixture (iron powder, copper metal, iron oxide and copper acetate) heated in a bomb

for 5 hours at 160° C., cooled, filtered and the volatile matter removed by evaporation. A yield is given of 24·8 parts of a pale yellow, very viscous, oily polymer of iodine number of approximately 400, readily soluble in organic hydrocarbons, which forms hard, tough, adherent coatings of excellent durability and chemical resistance, drying being accelerated by the usual catalysts. C. L. G.

Refining and Refinery Plant.

997.* Butane as a Source of Motor Fuel Volatility. J. W. Vaiden and J. O'Reilly. *Petrol. Engr*, May 1942, **13** (8), 116.—Of recent years refiners have sought means of utilizing butane to the best advantage, so that its use as refinery fuel gas could be avoided. The methods utilized included direct sales, with and without propane admixture, as fuel for industrial and household purposes, direct use as motor fuel in trucks fitted with special fuel systems, use as raw material for polymerization units and, most important, increased incorporation in motor fuel as a result of reduction of propane content achieved by better fractionation. Consequently refiners have become increasingly dependent on butane as a source of volatility and anti-knock quality for motor gasolines. The enormous demand for butane as raw material for preparation of 100 octane aviation gasoline and of synthetic rubber thus creates a difficult problem for refiners in connexion with motor-fuel quality. The position is further aggravated by restriction of tetraethyl lead supplies and probably reduction in quality and quantity of natural gasoline available due to *iso*butane and *iso*pentane extraction, and expected curtailment of carbon-black manufacture. It is probable that the butane output of many of the smaller refineries and natural gasoline plants will be available for the present, owing to the fact that installation of small alkylation and isomerization units is not yet economically feasible, but conversion of butane heating systems to use propane only, and of trucks using butane to run on motor fuel is likely to be restricted by steel requirements.

It is suggested that part of the butane deficiency can be made good by incorporation of propane, and the modification of specifications may become necessary to permit the use of propane instead of butane to give a finished motor fuel of approximately the same vapour pressure as at present allowed. In addition, the changed conditions will necessitate more efficient operation of present plants, and possibly installation of new equipment to ensure maximum extraction of butanes and propane, although such measures may not have been economically justified in the past.

A change in the demand–supply balance will probably further assist the position. Increased reforming of straight-run gasolines to produce butenes will probably be necessary, and this will automatically reduce the quantity of motor fuel available and increase the yield of cracked gases. Demand for motor fuel is also expected to decline. Careful planning is recommended, especially in plants expecting to supply butanes for war purposes, otherwise a period during which no satisfactory motor fuel can be prepared may arise. R. A. E.

998.* Substitute Metals and Alloys for Refinery Uses. B. B. Morton. *Petrol. Engr*, May 1942, **13** (8), 130.—In view of the present shortage of metals such as chromium, nickel, copper, etc., the possibilities of substitute materials for various refinery uses are discussed. For sub-zero temperatures down to — 75° F. carbon steels properly treated with aluminium and controlled as to grain size offer the best present substitute for nickel-containing steels.

Where metal temperatures of 1200–2000° F. are involved, and particularly where replacement is difficult and expensive, no change from the usual 25% chromium 12% nickel type of alloy steels is to be recommended in view of the markedly superior resistance to corrosion and the superior strength at high temperature of this alloy. Possible substitutions in the high-temperature range are listed.

In the low-temperature range, defined as the region in which liquid water exists, the demand is mainly for non-ferrous alloys, the type being dependent on the nature of the corrosive material encountered in the particular service. In order to conserve copper, substitution of these alloys by cast-iron equipment for condensers, coolers, pumps, etc., is being considered and put into practice. A list of possible substitutions in the low-temperature range for various services is given. R. A. E.

999.* What can be done about Sulphur in the Refinery. A. W. Trusty. *Petrol. Engr*, May 1942, **13** (8), 72.—The average cost of corrosion to the refiner is 1 c. per gallon of refined gasoline. In addition, the cost of treatment of distillates of high sulphur contents to meet specifications has been enormous, and the effects of sulphur compounds in reducing lead susceptibility and gum inhibitor susceptibility are well known.

The sulphur compounds of most interest to the refiner are hydrogen sulphide and mercaptans. The hydrogen sulphide contents of sour gases from some American fields are quoted. Caustic soda is usually employed for removing hydrogen sulphide from liquid petroleum fractions, but cannot be used economically for treatment of gases containing considerable amounts of hydrogen sulphide. For such gases the Shell process involving treatment with a solution of tripotassium phosphate, or the Girbotol process involving absorption in an aliphatic amine solution, may be applied, in both cases the treating medium being regenerated and the H_2S removed either burned or used for acid manufacture. The processes are briefly described.

Doctor treatment almost invariably results in lowering of octane number and lead susceptibility of the gasoline, but these effects may be reduced by pretreatment with caustic soda solution. Control of the doctor treatment is of great importance, and best results are obtained when (*a*) the temperature of the gasoline is held above 85° F., (*b*) addition of sulphur is made in solution in sweet rather than sour gasoline, (*c*) addition of sulphur follows doctor contact rather than preceding it, (*d*) adequate contact time of doctor solution and sour gasoline is allowed. For economies in consumption of chemicals and tetraethyl lead, especially in war-time, elimination of doctor test from specification is advisable. Substitution by a maximum mercaptan content, including a provision for removal of light mercaptans by specifying that none can be removed by a 5% soda solution, is suggested. Methods designed to remove mercaptans from sour gasolines include the caustic-methanol and the solutizer processes, which are briefly described. Reductions in sulphur contents and improvements in octane ratings and lead susceptibilities of gasolines treated by the caustic-methanol process are illustrated. To eliminate the adverse effects on lead susceptibility of polysulphides formed during doctor treatment and of other sulphur compounds present in gasolines, methods for desulphurization have been investigated. A Perco catalytic desulphurization unit installed in a natural gasoline plant in West Virginia reduces the total sulphur content of the gasoline from 0·26% to 0·004%, increases the initial octane rating by 3½ numbers, and greatly improves lead susceptibility. The process involves heating the product in a pipe-still, passing the vapours through a bauxite catalyst under a pressure of 40 lb. to convert sulphur compounds to hydrogen sulphide. After condensing and cooling the gasoline, the sulphide is removed by caustic wash. Catalyst yield is 4000–5000 brl. of gasoline per ton. Methods for determining the percentages of free sulphur and of the various types of sulphur compounds present in a petroleum distillate are given, and the distribution in distillates from Oregon Basin, Wyoming, crude oil shown. R. A. E.

1000. Patents on Refining and Refinery Plant. U. B. Bray. U.S.P. 2,281,667, 5.5.42. Appl. 22.7.33. Method of refining petroleum oil containing paraffin waxes. The oil is mixed with liquefied hydrocarbon gases having a vapour pressure greater than atmospheric at ordinary atmospheric temperature. The mixture is then cooled to a temperature sufficient to congeal the wax content and passed through a settling tank to separate high-melting wax from the oil mixture. The remaining portion of wax content is separated by filtration.

F. B. Downing and C. J. Pederson. U.S.P. 2,282,513, 12.5.42. Appl. 26.7.39. Production of a viscous petroleum oil normally subject to deterioration in colour, but which has incorporated in it a small amount of an organic compound of the type of Schiff's base, obtained by condensing 1 mol. of an aliphatic polyamine containing at least two primary amino-groups directly attached to different carbon atoms of the same open chain with at least 2 mols. of an aldehyde, so that 1, and only 1, mol. of aldehyde reacts for each primary amino-group of the polyamine.

H. G. M. Fischer and W. James. U.S.P. 2,282,514, 12.5.42. Appl. 26.7.39. Production of colour stabilized light petroleum oils from hydrocarbon oils by subjecting the oil to contact with air while in the presence of 3–5 gm. of iron oxide consisting of

Fe_2O_3 per 1000 c.c. of oil at a temperature between 200° and 350° F. The iron oxide is removed from the oil without withdrawing substantial amounts of colour bodies by distillation.

D. R. Stevens and J. E. Nickels. U.S.P. 2,282,594, 12.5.42. Appl. 2.3.39. Method of producing a doctor-sweetened gasoline having improved resistance to oxidation changes and improved response to anti-oxidant and anti-knock compounds. The gasoline containing mercaptans is treated with a solution of sodium plumbite in an amount sufficient to convert the reactive mercaptans to lead mercaptides, and with sulphur in an amount just sufficient to convert these mercaptides to alkyl disulphides. Afterwards the lead sulphide–gasoline suspension thus formed is treated with a solution of sodium tetraborate having a concentration sufficient to increase the settling rate of the suspension without rendering the gasoline sour.

M. A. Dietrich. U.S.P. 2,282,710, 12.5.42. Appl. 14.6.39. Method of inhibiting deterioration of petroleum hydrocarbons in the presence of metals normally active to catalyse deterioration. Incorporated in the petroleum hydrocarbons is a small amount of an organic compound having an amino-nitrogen atom and a divalent sulphur atom each singly bonded to adjacent aliphatic carbon atoms in open-chain configuration.

V. L. Chechot. U.S.P., 2,286,344, 16.6.42. Appl. 9.12.39. Process of acid-refining viscous hydrocarbon oil with the production of acid sludge characterized by its ready pumpability. The oil is contacted with sulphuric acid in the presence of an added amount of finely-divided elemental sulphur. The resultant acid-sludge is settled and the sludge separated from the oil.

V. L. Chechot. U.S.P. 2,286,345, 16.6.42. Appl. 16.2.40. Production of mineral white oil by fuming sulphuric acid treatment. The acid is applied in a plurality of multiple dump treatments, each of which treatments comprises a plurality of successive steps of acid addition and agitation. The acid sludge is removed from the treated oil only on the completion of each of the multiple-dump treatments.

J. R. Miller. U.S.P. 2,286,369, 16.6.42. Appl. 2.1.31. Method of purifying used lubricating oil by mixing with it a solid impurity-adsorbing material, mechanically agitating the mixture heated to a temperature to cause volatile impurities to be liberated, while contacting the surface of the oil-body with air. Afterwards vapours of volatile impurities are withdrawn from the oil and the oil is treated to separate solid material from it.

A. Y. Mottlam. U.S.P. 2,287,118, 23.6.42. Appl. 29.4.38. Process for the removal of organic sulphur compounds of the mercaptan type from a mineral oil boiling in the range 100–700° F. The oil is treated with an aqueous solution of an aliphatic amino alcohol at atmospheric pressure and at a temperature between 60° and 85° F.

A. J. Mueller. U.S.P. 2,287,119, 23.6.42. Appl. 2.2.39. Method of removing soluble impurities from a hydrocarbon product which involves bringing it into contact with a solid adsorbent. The adsorbent is wetted with a substantially pure low-molecular-weight aliphatic alcohol.

Le R. G. Story. U.S.P. 2,288,754, 7.7.42. Appl. 23.6.34. Method of inhibiting gum formation in cracked hydrocarbon distillates by the addition of 0·01–0·1% of α-naphthol.

W. H. Sowers. U.S.P. 2,288,853, 7.7.42. Appl. 15.5.39. Process of concentrating the aromatic content of hydrocarbon distillate which is completely miscible with liquid sulphur dioxide. The distillate is extracted at temperatures below the freezing point of water with a solvent comprising sulphur dioxide, alcohol, and water. Afterwards the solvent is removed from the distillate.

G. Egloff. U.S.P. 2,291,885, 4.8.42. Appl. 21.8.40. Conversion of hydrocarbon oil by subjecting it to desulphurizing conditions in the presence of a desulphurizing catalyst and hydrogen. In this way are formed hydrogen sulphide from sulphur compounds and a substantially sulphur-free oil.

D. L. Campbell. U.S.P. 2,293,241, 18.8.42. Appl. 22.6.40. Process for the segregation of hydrocarbon constituents containing three and less hydrocarbon atoms in the molecule from hydrocarbon constituents containing four and more carbon atoms in the molecule, and also for the segregation of a gas stream comprising hydrogen from feed-gas mixtures containing the same.

L. L. Lovell. U.S.P. 2,293,395, 18.8.42. Appl. 18.8.41. Improved process of sweetening sour hydrocarbon oil containing mercaptans by treatment with a copper catalyst. In this way mercaptans are converted to disulphides.

W. B. Chenault. U.S.P. 2,293,591, 18.8.42. Appl. 18.8.39. Method of treating acid raffinates from solvent extraction processes using a solvent blend containing sulphuric acid. The acid raffinate is almost completely neutralized by means of an absorptive earth, and the solvent is then stripped from the neutralized raffinate. Subsequently the oil content of the raffinate is decolorized by contact with fresh adsorptive earth.

E. A. Ocon. U.S.P. 2,294,126, 25.8.42. Appl. 12.9.38. Process for distilling and fractionating a crude petroleum oil in heat exchange with heat-treated hydrocarbon products undergoing fractionation.

C. G. Gerhold and B. J. Flock. U.S.P. 2,294,547, 1.9.42. Appl. 10.10.38. Process for the recovery of a normally gaseous fraction rich in polymerizable olefins from the mixture of vapours and gases produced in the conversion of hydrocarbons.

H. B. M.

Metering.

1001.* Technique of Precision Control in Refining Processes. R. B. Werey. *Petrol. Engr*, May 1942, **13** (8), 86.—The demand for increased output, the shortage of skilled labour, and the need for producing materials of greater purity are factors which have led to increased necessity for more precise automatic control. Improvements in design of plants resulting in reduced stored heat capacities and increased thermal potentials emphasize this need, but accentuate the difficulties of control. The effects of process conditions, such as mass or capacity of system, thermal potential used in heating and cooling, conductivity of materials used in heat-transfer equipment and other factors, on the time lag or interval between change in conditions and the corresponding effect on the recorder or controller are discussed. Proper adjustment of controllers is accomplised by synchronizing the rate of heat input with the rate of heat absorption, so that a rate of automatic reset as well as a throttling range adjustment is an essential part of an efficient controller.

Special consideration is given to control of fractionating columns designed to separate relatively pure products from a variety of feed-stocks. Whilst the degree of perfection attained in the control of the tower temperature is the criterion for determining the effectiveness of the entire control system, minimizing the rates of change of other controllable variables greatly simplifies the problem of control. The actual position of the sensitive element of the temperature controller for most efficient control for the separation desired must be determined experimentally, but fitting of several thermocouple wells in the region selected is desirable, so that shifting of the couple can be accomplished whilst the unit is in operation. Introduction of a mixing vessel in the line to iron out major variations in feed composition may be necessary in some cases. Variations in main-line steam pressure may be controlled by interlocking the tower-temperature controller with a rate of flow controller on the steam line to reboiler.

Control of tower pressure can be obtained in several ways. Where cooling water flow is throttled, it is desirable to interlock a rate of flow controller in the water line with the pressure controller to eliminate the effect of changes in water rate due to changes in pressure differential across the control valve. The importance of rate of feed control is stressed. The Brown system of control of fractionating columns for production of cuts of narrow boiling range is illustrated. R. A. E.

Chemistry and Physics of Hydrocarbons.

1002.* Cetane Numbers and Physical Properties of Normal Alkyl Benzenes and Other Hydrocarbons. Part III. Evaluation of *n*-Alkyl Benzenes and Certain Related Hydrocarbons as Diesel Fuels. T. Y. Ju, C. E. Wood, and F. H. Garner. *J. Inst. Petrol.*, August 1942, **28** (224), 159–171.—The cetane numbers of *n*-dodecyl benzene and *n*-tetradodecyl benzene were found to be 68 and 72, respectively. The blending curves for these two *n*-alkylated benzenes with low-standard-reference fuel are straight lines.

The blending cetane numbers of three diphenyl homologues were obtained by interpolation or extrapolation from blends with high-standard diesel reference fuel: the blending curves are not linear. The cetane number of *m*-di*iso*propyl benzene is too low to be run straight in the engine. The blending cetane number of the unblended hydrocarbon as obtained by extrapolation is — 12.

A summary is given of blending cetane numbers obtained in the present work and of those previously published in the literature, and, while the data are incomplete, they indicate that the hydrocarbons with a compact or highly branched structure tend to have low cetane numbers. There is thus a general similarity existing between octane number and cetane number, in that the type of structure which gives a high octane number also gives a low cetane number. A. H. N.

1003. Patent on Chemistry and Physics of Hydrocarbons. Shell Development Co. E.P. 546,148, 30.6.42. Appl. 31.1.41. Process for transferring components from their solution in one phase to another phase which is substantially immiscible with the first phase. As an example of the process, the extraction of mercaptans from hydrocarbon oils with aqueous solutions of caustic alkali is given. In the first place, the solution is fractionated to produce at least two fractions containing portions of extractable components, the fractions having different degrees of ease of transference towards the solvent. The solvent is then flowed through an extraction zone and withdrawn from it. At different points in the direction of flow of the solvent are introduced the fractions in order of decreasing ease of transference of their solutes to be extracted. These are then flowed through at least part of the zone in countercurrent to the solvent. Finally the fractions are combined in the zone and withdrawn. H. B. M.

Motor Fuels.

1004. Patents on Motor Fuel. Standard Oil Development Co. E.P. 546,406, 13.7.42. Appl. 19.4.40. Production of normally liquid saturated hydrocarbons suitable for use as a motor fuel by the alkylation of saturated hydrocabons containing at least one tertiary carbon atom per molecule, with mono-olefines. The process involves the use of a catalyst consisting of water saturated with boron trifluoride. The mixture to be treated contains an excess of ethylene over the equimolar quantities of olefin and saturated hydrocarbons.

Texaco Development Corp. E.P. 546,640, 23.7.42. Appl. 10.10.40. Preparation of a motor fuel consisting essentially of a blend of substantial portions of aromatic hydrocarbons within the gasoline boiling range and a saturated paraffinic hydrocarbon fraction of comparatively broad gasoline boiling range. The fuel consists essentially of *iso*paraffinic hydrocarbons and a minor proportion of saturated C_3 and C_5 paraffinic hydrocarbons, and is substantially free from normal paraffin hydrocarbons of higher molecular weight than normal pentane. The blending octane number by the C.F.R.M. method of a 50% blend of benzene with the saturated paraffinic components of the fuel is at least 93·8.

R. P. Frazer. E.P. 547,029, 11.8.42. Appl. 16.10.40. Method of preparing a pumpable and highly stable combustible mixture of liquid and pulverized coal. The coal is reduced to a state of fineness such that 100% will pass through a screen of 300 mesh, and it is then compounded with a viscous mineral oil and a substantial proportion of a liquid of coal-tar distillate origin, *e.g.*, one containing cresol and/or indene and/or pyridine.

Standard Oil Development Co. E.P. 547,077, 12.8.42. Appl. 27.3.41. Production of a motor fuel consisting of a hydrocarbon fuel base adapted for spark ignition engines, blended with at least 2% of an *N*-alkylated aromatic amine containing an oxygenated aliphatic substituent group in the aromatic nucleus.

W. J. Backoff, N. D. Williams, J. F. O'Loughlin, and H. L. Moir. U.S.P. 2,284,080, 26.5.42. Appl. 6.10.38. Preparation of a composition for use as a gum solvent and consisting of 50–90% of refined mineral oil boiling above the boiling range of kerosene and 50–10% of a mixture of esters of phthalic and benzoic acids boiling above 350° F.

L. C. Kemp. U.S.P. 2,286,814, 16.9.42. Appl. 28.10.39. Process for the manufacture of high-anti-knock motor-fuel hydrocarbons. The process includes catalytically converting a mixture of carbon monoxide and hydrogen to a synthetic hydrocarbon mixture composed mainly of hydrocarbons having from 1 to 10 carbon atoms per molecule, the C_3–C_4 fraction of which consists essentially of aliphatic hydrocarbons composed largely of olefins and relatively free from *iso*butylene. From this synthetic mixture is separated a fraction rich in normal butane and another fraction rich in normal butylenes. The butane-rich fraction is subjected to isomerization to form *iso*butane, which latter is separately reacted with the butylene-rich fraction by contact with an alkylation catalyst to produce normally liquid saturated hydrocarbons having a high anti-knock value and boiling within the motor-fuel range.

T. H. Rogers and V. Vorhees. U.S.P. 2,287,359, 23.6.42. Appl. 20.8.30. Method of preserving a cracked hydrocarbon distillate which tends to deteriorate and develop gum on storage. Incorporated in the distillate is a trace of naphthol, less than 1%, but sufficient substantially to retard such deterioration.

A. B. Hersberger. U.S.P. 2,287,736, 23.6.42. Appl. 16.5.39. Separation of an oil which contains paraffinic and naphthenic hydrocarbons into fractions respectively more paraffinic and more naphthenic than the original oil by extracting with a solvent consisting of morpholine and a lower aliphatic alcohol.

E. L. D'Ouville. U.S.P. 2,288,875, 7.7.42. Appl. 30.12.39. Process of converting hydrocarbon oils which comprises contacting the oils with a catalyst prepared by the gelation of blast-furnace slag with an acid wherein the slag is partly dissolved, washing, drying, and igniting the resultant gel.

A. J. Van Peski. U.S.P. 2,289,605, 14.7.42. Appl. 9.5.39. Production of a motor fuel comprising a gasoline-type motor fuel and a small amount of a knock suppressor consisting of a compound combining a metal having an atomic number from 26 to 29 inclusive, with an organic component, having a basic structure which contains an atom combination selected from the group consisting of N = C — N — C = O and N = C — N — C — N, or their tantometers, the structure containing at least two double bonds.

R. F. Marschner. U.S.P. 2,289,716, 14.7.42. Appl. 19.10.39. Method of lowering the acid heat of catalytically cracked gasoline without unduly impairing its octane number and tetraethyl lead response. The gasoline is fractionated into a light fraction having an end-point of 150–250° F. and a heavy fraction. The light fraction is hydrogenated to effect at least 20% saturation, but not more than 90% saturation of the olefins contained therein. Finally the partly hydrogenated light fraction is blended with the unhydrogenated heavy fraction.

C. L. Thomas. U.S.P. 2,292,677, 11.8.42. Appl. 17.5.39. Process involving contact of a hydrocarbon distillate with a cracking catalyst under catalytic cracking conditions and separating the gas and gasoline. The gasoline is separated into a low- and a high-boiling fraction, and the gaseous products are separated into a plurality of fractions. One of these comprises essentially hydrogen and uncondensable hydrocarbon gases, and another a fraction consisting essentially of C_3 and C_4 hydrocarbons. C_3 and C_4 olefins are catalytically polymerized, and those polymers boiling within

the gasoline boiling range are combined with the low-boiling gasoline fraction from the cracking operation. The mixture is contacted with a hydrogenation catalyst and the hydrogenation product recovered. Afterwards it is blended with the high-boiling gasoline fraction from the cracking operation.

J. M. Mavity. U.S.P. 2,292,708, 11.8.42. Appl. 31.10.40. Process for catalytically converting hydrocarbon oil into high anti-knock gasoline. Disposed in the oil is an alkyl silicate and a metal alkoxide capable of reacting with the alkyl silicate to form a conversion catalyst *in situ*. The hydrocarbon oil mixture is subjected to catalytic conversion to produce a substantial yield of gasoline.

P. J. Harrington. U.S.P. 2,293,205, 18.8.42. Appl. 16.9.39. Production of motor fuel from a petroleum oil boiling below 420° F. The fuel has a high octane number and a high susceptibility for knock-suppressing agents. The oil has a sulphur content of less than 0·1%, and is of a character which could normally be desulphurized by bauxite treatment. 0·1–0·5% of free sulphur is added to the oil, which is then passed over a bauxite catalyst. Temperature and pressure are so controlled that substantially no cracking of the oil occurs. H. B. M.

Gas, Diesel, and Fuel Oils.

1005. Patent on Gas, Diesel and Fuel Oils. S. H. Hulse and J. O. Collins. U.S.P. 2,288,401, 30.6.42. Appl. 28.3.40. Method for improving sour Diesel-fuel petroleum distillates which involves adding thereto distillate oil containing at least 10 mg. of mercaptan sulphur per 100 ml. of oil, lead sulphide, an alkali, and reactive sulphur. The reactive sulphur is added in a proportion to form, by reaction with the mercaptans, stabilized organic compounds containing from 20 to about 200 mg. of active sulphur per 100 ml. of the oil. H. B. M.

Lubricants and Lubrication.

1006.* Changing Concepts of Petroleum Lubricants. J. W. Poole. *Petrol. Engr*, May 1942, **13** (8), 140–145.—It is now becoming more widely recognized that only engine performance can be depended on as a criterion of lubricants. In the past, research was, generally speaking, more concerned with finding more exact or efficient ways of meeting traditional specifications. These specifications are still used in the majority of cases, and tests are made for, and oils judged by gravity, flash point, fire test, viscosity, viscosity index, pour point, colour, neutralization number, Conradson carbon, unsulphonated residue, corrosion, sulphur content, oxidation tests, and emulsion tests.

Each test method is reviewed, and its significance and limitations commented on, with appropriate literature references. Many are useful for plant-control purposes, but from the service point of view the significance often attached to them is not justified by the evidence now available, and deductions made from the results of such tests are sometimes misleading. Even when considered collectively, conventional specifications based on these laboratory determinations are inadequate, since they provide no certain assurance that oils complying with them will give the best, or even satisfactory service performance. R. A. E.

1007. Oil Dermatitis. Anon. *Chem. Tr. J.*, 26.6.42, 110, 662.—The May issue of the *Industrial Accident Prevention Bulletin* of the Royal Society for the Prevention of Accidents discusses the value of adding antiseptics to cutting oils to reduce dermatitis. The usefulness of antiseptics is considered debatable, although oils can contain appreciable quantities of bacteria. Dermatitis is primarily caused by dirty oil blocking the pores of the skin, though minute particles of metal and the presence of any free alkali aggravate conditions. Bulletin No. 2 of the D.S.I.R. entitled "Memorandum on Cutting Lubricants and Cooling Liquids and on Skin Diseases Produced by Cutting Lubricants," states that the addition of antiseptics—*e.g.*, 1–2% carbolic acid, to lubricants and of 0·5% of water-soluble disinfectants to cutting emulsions—has not given altogether satisfactory results and cannot be relied upon to prevent

skin rashes. The American Mutual Insurance Co. at one time advocated 2% of paraformaldehyde or 5 oz. of phenol to every 5 gal. of oil. Commercial disinfectants are sold for use with cutting oils, or are added to the oils during manufacture but the addition of antiseptics is less common nowadays in the U.S.A. C. L. G.

1008. Patents on Lubricants and Lubrication. J. E. Schott. U.S.P. 2,281,623, 5.5.42. Appl. 30.7.41. Preparation of a substantially liquid and non-stringy lubricating oil for internal-combustion engines operating at high sustained speeds and under severe conditions of temperature and pressure such as may be encountered in Diesel-engine lubrication. The composition consists of a mineral lubricating oil compounded and heated with small amounts of an aluminium soap of a saturated fatty acid and a compound selected from the class consisting of glycol mono-ethers and di-glycol mono-ethers in such proportions that the viscosity of the oil is not materially increased.

U. B. Bray. U.S.P. 2,281,824, 5.5.42. Appl. 22.9.42. Manufacture of a lubricating oil containing a relatively small proportion of an alkaline-earth metal soap of a saponifiable organic acid to overcome the deposition of resinous and varnish-like materials in severe service internal-combustion engines. The composition also contains a small quantity of an oil-soluble alkaline-earth metal compound of a thiophenolic derivative to overcome corrosive conditions developed in the oil. The added constituents do not materially increase the viscosity of the original lubricating oil.

E. Lieber. U.S.P. 2,281,942, 5.5.42. Appl. 20.5.38. Preparation of an addition agent for lubricating oils. A phenolic ester of a fatty acid having a chain of at least 10 carbon atoms is heated with a Friedel–Crafts catalyst at a temperature of at least 250° F. for a sufficient length of time to effect molecular rearrangement of the ester. Heating of the resultant reaction mixture is continued until the ester is substantially polymerized into higher-molecular-weight compounds. Afterwards an oil-soluble organic product of high boiling point is separated from these higher-molecular-weight compounds.

E. R. Barnard. U.S.P. 2,282,599, 12.5.42. Appl. 17.11.37. Prevention of "feathering" of piston rings in high-speed Diesel engines while such rings are coated with a film of synthetic hydrocarbon lubricating oil produced by the catalytic polymerization of liquid *iso*butylene at a temperature between 0 and 100° F. 0·001–0·2% of a substance selected from the class consisting of the oil-soluble compounds of oxygen, sulphur, phosphorus, and chlorine is dissolved in the lubricating oil.

B. T. Brooks. U.S.P. 2,284,258, 26.5.42. Appl. 18.3.37. Preparation of a lubricant consisting of a mineral lubricating oil and a small amount of an oleone.

Texaco Development Corp. E.P. 547,286, 21.8.42. Appl. 15.2.40. Preparation of a lubricating oil for the bearing surfaces of an internal-combustion engine. The lubricant consists of a mineral oil having incorporated in it 0·01–2·0% by weight of a corrosion-inhibiting compound consisting of a tri-alicyclic ester of phosphorous acid in which the alicyclic radicals are selected from the group consisting of *cyclo*hexyl and alkyl-, aryl-, and aralkyl-substituted *cyclo*hexyl radicals.

G. E. Merkle. U.S.P. 2,285,452, 9.6.42. Appl. 26.2.40. Manufacture of a lubricant of the class consisting of oil and grease bases and containing dispersed therein 3½–15% by weight of unsaponified basic lead carbonate.

G. E. Merkle. U.S.P. 2,285,453, 9.6.42. Appl. 9.4.40. Preparation of a lubricant containing, as a wear-reducing agent, finely divided titanium dioxide up to 10½% by weight.

G. E. Merkle. U.S.P. 2,285,739, 9.6.42. Appl. 9.5.40. Preparation of a lubricant which contains finely divided zinc sulphide dispersed therein and is characterized by its freedom from ingredients which would cause progressive abrasion action on the wearing surfaces to which it is applied.

E. Lieber. U.S.P. 2,287,110, 23.6.42. Appl. 29.12.38. Manufacture of a lubricant consisting of a waxy hydrocarbon oil and a condensation product of a ketone having carbocyclic and open-chain aliphatic radicals of at least 6 carbon atoms with a short-chain dihalo aliphatic hydrocarbon of 1 to 5 carbon atoms.

M. Pier and F. Christmann. U.S.P. 2,287,901, 30.6.42. Appl. 17.4.33. Preparation of a lubricant consisting of a viscous hydrocarbon containing a waxy distillation residue of a product prepared by the condensation of an acid chloride of a carboxylic acid having a molecular weight of more than 200.

B. H. Lincoln. U.S.P. 2,288,288, 30.6.42. Appl. 26.8.38. Preparation of a lubricant consisting of a major proportion of an oil of lubricating viscosity and a minor proportion of dithylarsenic phenyl stearate.

B. H. Lincoln, G. D. Byrkit, and W. L. Steiner. U.S.P. 2,288,289, 30.6.42. Appl. 17.4.40. Preparation of a lubricant consisting of a major portion of an oil of lubricating viscosity and a small amount of a stannic salt of an organic acid bearing at least one aromatic ring.

W. M. Malisoff. U.S.P. 2,289,509, 14.7.42. Appl. 1.11.33. Production of a lubricant consisting of a viscous hydrocarbon oil and a halogenated ester of a phosphorus acid.

A. Beerbower and A. J. Morway. U.S.P. 2,289,748, 14.7.42. Appl. 18.2.39. Preparation of an improved grease composition consisting of 5–50% of soda soap in mineral lubricating oil, a slight excess of acid and, as an inhibitor of oxidation, a small amount of guaiacol.

J. G. McNab. U.S.P. 2,289,795, 14.7.42. Appl. 1.9.39. Preparation of a lubricating composition consisting of a mineral lubricating oil and small amounts of polyvalent metal salts selected from each of the groups consisting of aluminium and alkaline-earth metal salts. The total amounts of these salts is 0·1–3·5% by weight of the oil, and the amount of each type of metal salt is at least one-tenth of the total metal salt present.

R. E. Burk. U.S.P. 2,290,032, 14.7.42. Appl. 21.4.39. Manufacture of a lubricating composition consisting of a lubricating oil having colloidally dispersed therein an iron compound from the group consisting of oxides and sulphides. The iron compound is present in relatively small but sufficient amount to improve the extreme pressure properties of the oil.

E. W. Cook. U.S.P. 2,290,316, 21.7.42. Appl. 21.1.41. Preparation of a lubricant consisting of a major proportion of a mineral lubricating oil and a minor proportion of a sulphurized aldehyde amine.

S. P. Waugh. U.S.P. 2,291,066, 28.7.42. Appl. 10.1.41. Manufacture of a lubricant suitable for use in metal working operations and consisting of a stable aqueous emulsion containing mineral oil, a saponified component derived from the fatty acid mixture obtainable from palin oil, and a phosphorus-containing substance effective to increase the load-carrying capacity of the composition.

O. L. Maag. U.S.P. 2,291,166, 28.7.42. Appl. 7.1.39. Preparation of a lubricating composition containing a major proportion of a lubricating oil and up to 10% of a fluorinated member of the paraffin series heavier than methane.

A. J. Morway. U.S.P. 2,291,404, 28.7.42. Appl. 24.12.36. Preparation of a lubricating composition consisting of a lubricating oil and a sulphurized *iso*butylene polymer having a molecular weight above 1000.

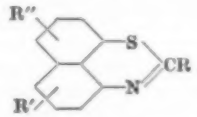
F. M. Watkins. U.S.P. 2,292,308, 4.8.42. Appl. 11.10.40. Preparation of a lubricant consisting of a petroleum lubricating oil and a metal salt of an alkyl monoester of an alkenyl-substituted succinic acid. The metal is selected from the group consisting of calcium, aluminium, barium, cadmium, chromium, magnesium, nickel, tin, and zinc.

B. H. Lincoln and G. D. Byrkit. U.S.P. 2,292,456, 11.8.42. Appl. 18.7.40. Preparation of a lubricant consisting of a hydrocarbon oil and a minor porportion of trimethylene-1-, 2-disulphide.

R. A. Swenson. U.S.P. 2,292,672, 11.8.42. Appl. 29.6.40. Preparation of a semi-fluid lubricant consisting of petroleum oil, 25–55% of blown asphalt and 2–20% of high lead soap comprising the reaction product of litharge and a fatty oil of fish origin.

C. E. Earle. U.S.P. 2,293,052, 18.8.42. Appl. 4.11.40. A lubricant consisting of a mineral oil, a lithium soap, and a calcium soap. The proportion of the soaps is at least sufficient to thicken the oil substantially, but is not in excess of 40% of the total. Lithium constitutes a sufficient proportion of the added soaps to increase the viscosity of the oil.

J. H. Bartlett. U.S.P. 2,293,237, 18.8.42. Appl. 29.12.39. Preparation of a lubricant consisting of a mineral lubricating oil and a small quantity of a compound of the formula :



in which R . R′ and R″ are selected from the class consisting of hydrogen and halogen atoms and amino, mercapto, hydroxyl, and organic groups.

P. R. Van Ess. U.S.P. 2,293,419. 18.8.42. Appl. 27.5.41. Process for dissolving in a mineral oil a difficultly soluble open salt combining a polyvalent metal with an aromatic hydroxy monocarboxylic acid, in which the carboxylic radicle is directly attached to the aromatic nucleus. In this way is produced an anti-ringsticking lubricating oil.

J. F. Nelson. U.S.P. 2,293,445, 18.8.42. Appl. 19.11.38. A lubricant consisting of a highly refined mineral oil and tritertiary butyl *ortho* hydroxy phenyl phosphite.

S. P. Waugh. U.S.P. 2,294,526, 1.9.42. Appl. 22.5.41. A lubricant consisting of a hydrocarbon oil in which has been dissolved a neutral metal soap of a character not normally soluble in the oil. Solution is achieved by adding a sufficient amount of a sulphocarboxylic acid.

V. L. Ricketts. U.S.P. 2,294,804, 1.9.42. Appl. 1.6.36. Production of a lubricant for metallic bearing surfaces consisting of a mineral lubricating oil and a small amount of an aliphatic ester of phosphorous acid in which each aliphatic group has from 1 to 5 carbon atoms.

W. J. D. Van Dijck. U.S.P. 2,294,817, 1.9.42. Appl. 3.4.34. Preparation of a lubricant for metallic bearing surfaces consisting of a lubricating oil to which has been added a small amount of a reaction product of a fatty oil and an oxide of phosphorous. H. B. M.

Asphalt and Bitumen.

1009. Patents on Asphalt and Bitumen. Standard Oil Development Co. E.P. 547,242, 19.4.42. Appl. 31.3.41. Production of an aqueous emulsion of bitumen of the oil-in-water type containing a compound of a metal selected from the following : aluminium, tin, boron, chromium, zinc, molybdenum, and vanadium.

Standard Oil Development Co. E.P. 546,523, 17.7.42. Appl. 27.7.40. Process for obtaining light-coloured plastic materials from the asphaltic residues from the distillation of petroleum oils. The residue is treated with a solvent which dissolves the light-coloured bitumen alone or together with other components of the residue.

The solution thus obtained is treated to remove black asphaltenes if present and the remaining solution treated with a decolorizing agent. Finally the decolorizing agent is removed and the solution is treated to separate the light plastic components.

J. Miller. U.S.P. 2,281,854, 5.5.42. Appl. 2.8.40. Apparatus for manufacturing cylindrical containers of paper material suitable for packaging asphalt.

R. E. Burk. U.S.P. 2,282,703, 12.5.42. Appl. 28.10.36. Method of manufacturing asphalt which involves oxidizing petroleum residuum by heating and agitating in exposure to oxygen and thickening to desired melting point and penetration. After oxidation there is incorporated in the mixture a small amount of a naphthenate of a metal of the group consisting of cobalt, manganese, lead, vanadium, and zinc.

C. H. Whitacre. U.S.P. 2,286,244, 16.6.42. Appl. 9.12.40. Incorporation with asphaltic material of small amounts of wood, liquid rosin acids, and a sulphate of a metal from the alum-forming metals, aluminium, and iron.

A. B. Hersberger. U.S.P. 2,286,414, 16.6.42. Appl. 5.8.39. Production of an asphalt of reduced staining tendency from flux asphalt. A small quantity of a substantially water-insoluble soap is added to the flux to cause gelation of the exudable oil content. Afterwards the mixture is airblown at a high temperature.

R. E. Burk and C. H. Whitacre. U.S.P. 2,287,511, 23.6.42. Appl. 23.11.36. Manufacture of asphalt by heating to 350–400° F. and thickening a petroleum residuum, in the absence of injected air, to asphalt consistency with a small amount of an aluminium chloride catalyst.

D. R. Wiggam. U.S.P. 2,289,229, 7.7.42. Appl. 6.4.38. Preparation of a composition comprising in homogeneous admixture a bituminous material selected from the group consisting of coal tar, pine tar, gilsonite, and stearin pitch; and ethyl cellulose. The composition consists of non-volatile substances, and has a higher softening point and greater toughness than the bituminous material. H. B. M.

Special Products.

1010. Calcium Naphthenate. Anon. *Chem. Tr. J.*, 19.6.42, 110, 634. The uses of calcium naphthenate in the paint and varnish industries is discussed by A. Minch in the April 1942 issue of Canadian Chemistry and Process Industries. These include (*a*) as bodying agent for the slower bodying oils in varnish cooking, (*b*) as drier in cases where pigment darkening which would result from the use of a lead salt, must be minimized, (*c*) as part or complete substitute for lead driers for use with vehicles which have a poor tolerance for lead driers, *e.g.*, oils containing saturated fatty acids which precipitate lead driers, and (*d*) as drier in conjunction with lead and cobalt for use with natural resin varnishes. C. L. G.

1011. Petroleum Resins in Paper Makers Sizes. Anon. *Chem. Tr. J.*, 26.6.42, 110, 17. In the 1941 *Proceedings* of the Paper Makers Association, papers given at a conference on "Sizing Problems in War-Time" in November 1941, are included. It was reported that satisfactory complete replacement of rosin could be effected by sulphurized oils (factis), particularly emulsions of lightly sulphurized rape oil, sodium stearate, and sodium naphthenate, and partial replacement by the softer grades of coumarone resins and by petroleum resins. Owing to the dark colour of petroleum resins, they were considered only for the production of wrapping papers made from stock containing kraft paper and general waste. Difficulties in emulsifying the petroleum resin alone were overcome by replacing only part of the rosin by petroleum resin and using the sodium rosinate as the dispersing and stabilizing agent. Papers produced with petroleum resin sizes are satisfactory as regards strength and other properties. C. L. G.

1012.* Deterioration of Over-Refined Insulating Oils. E. W. Steinitz. *Petroleum*, August 1942, **5** (8), 138.—In a large industrial works, in which oils meeting A30 specification had been used with satisfaction for years, switches commenced to give off a gas of acrid smell, and corrosion of metallic parts was observed six weeks after filling up with a fresh batch of oil meeting the same specification. The used oil in the switches was tested and results were: acid No. 3·4 mgm. KOH per gm., saponification No. 9·3 mgm. KOH per gm., water content 1·4%, breakdown voltage 6500. The cause of the trouble was eventually traced to interaction between the oil and an insulating "fibre" used in the switch. Similar material had been used in this and other switches for many years without difficulty. This "fibre" was found to be a couched cardboard containing resins and ground wood as well as cellulose. It was porous and hygroscopic, water content normally 15%. Fibre of this type should be dried and deaerated before immersion in oil. The present tendency of the electrical industry to use pure cellulose paper for submersion in oil is in line with the latest research work. The new oil was found to be of the over-refined type prepared from a different base and by a refining process different from that applied to previous supplies of A30 oil used. Discussions on the need for revising B.S.S. 148 have already taken place. Tentative conclusions reached from the results of the present investigation are: (1) Inclusion of acid-number determination after oxidation is desirable. (2) A second catalyst, preferably a fibrous material, ought perhaps to be included in a revised sludge test. (3) Consideration should be given to the base of the oil in selecting a refining method for insulating oils. (4) At a later stage some references to preferred bases and refining methods and the most desirable composition of the finished product might be included in the specification. R. A. E.

1013.* "Quick Rubber" Campaign under Way to Meet Civilian Transport Needs. Anon. *World Petrol.*, August 1942, **13** (9), 22.—Through improvements in the process of manufacture it has been found possible to increase the capacity of planned butyl rubber plants from 60,000 to 132,000 tons per annum without using additional materials of construction. The annual production of synthetic rubber under Government auspices is thus raised to about 900,000 tons to be achieved in 1944, with 300,000 tons scheduled for 1943. In addition to these specially designed plants, arrangements are being made to utilize existing facilities and available materials for the production of further quantities of butadiene, and for the conversion of this product into synthetic rubber of the Buna type for civilian requirements. The methods to be employed include: (*a*) thermal cracking at high temperature, (*b*) cracking with air injection, (*c*) cracking with superheated steam injection, (*d*) cracking with flue-gas injection. In addition, arrangements are in hand for the manufacture of Flexon, produced from *iso*butylene by addition of a catalyst at low temperatures, and of Thiokol. Both these products can be used for manufacturing tyres capable of giving limited mileage under not too strenuous driving conditions. Plans are also afoot for producing additional butyl rubber in makeshift plants. Extensive investigations are being carried out on alternative rubber substitutes and on methods of improving known processes of production of synthetic rubber and of manufacture of tyres from them. R. A. E.

1014.* Petroleum Resins—The Acrylic Resins. C. C. Pryor. *Petrol. Engr*, May 1942, **13** (8), 80.—The acrylic and methacrylic resins are products resulting from polymerization of the monomeric derivatives of acrylic acid, of which the esters, which form thermoplastic resins of unusual character, are of most importance commercially at present. These esters can be obtained from petroleum sources—*e.g.*, methyl methacrylate from propylene via acetone, acetone cyanhydrin and reaction with sulphuric acid and methyl alcohol. Polymerization of the esters may be accomplished under the influence of heat, light, oxygen, and/or peroxide type catalysts. Methacrylate esters can be cast-polymerized direct in predesigned moulds or can be first polymerized in finely divided form and subsequently moulded in any manner suitable for a thermoplastic resin. The resins possess outstanding clarity and light-carrying ability, but have limited compatibility with other synthetic polymers and natural resins. Apart from *iso*- and *n*-butyl methacrylate polymers, the five methacrylate polymers produced commercially are incompatible with each other, and co-polymerization of the monomers is necessary to obtain desired variations.

Properties of the five resins are given, those of the polymethyl methacrylate making this the most important commercially. This resin can also be readily moulded and handled. The extensive applications of the resins in the automotive, textile and aircraft industries, and to household articles are reviewed. R. A. E.

1015. Patents on Special Products. Universal Oil Products Co. E.P. 546,709, 28.7.42. Appl. 3.4.40. Manufacture of butadiene by subjecting normal butane to contact with a catalyst consisting of 80–99% of alumina and 1–20% of chromium oxide at a temperature between 550° and 650° C., under a pressure between 0·5 and 2·5 atmospheres, and for a time of contact between 0·05 and 1 sec. Afterwards the butenes thus obtained are subjected to a further contact with a separate portion of the same catalyst at a temperature between 500° and 700° C., under subatmospheric pressure, and for a time of contact not exceeding 1 sec. In this way a substantial yield of butadiene is obtained.

Standard Oil Development Co. E.P. 547,048, 11.8.42. Appl. 12.2.41. Continuous operation for the conversion of hydrocarbons to desired products while in the vapour phase. The vapours contain suspended therein a quantity of catalyst which may be in the form of a powder, granules, grains, lumps, shaped bodies, etc.

S. H. McAllister. U.S.P. 2,285,601, 9.6.42. Appl. 29.2.40. Production of glutaric acid by continuously introducing *cyclo*pentane into a nitric-acid-containing solution maintained at a temperature of about 110° C. The nitric acid in the solution is kept at about 14–20% by continuously adding nitric acid. The crude reaction mixture is removed and the glutaric acid recovered.

J. Delattre. U.S.P. 2,285,785, 9.6.42. Appl. 13.7.40. Method of producing more valuable products from a gaseous hydrocarbon mixture. The mixture is separated into three fractions, an *iso*butane fraction, a normal butane fraction, and a fraction comprising *iso*- and normal butenes. The normal butane fraction is subjected to dehydrogenation to form butene and hydrogen, and butene and unconverted normal butane are separated from the hydrogen. The butene and unconverted normal butane are combined with the *iso*- and normal butenes, and the mixture is then subjected to polymerization under conditions designed to polymerize substantially all the *iso*butene and only a portion of the normal butenes to *iso*octenes, leaving the quantity of normal butene unconverted approximately equal to the volume of *iso*-butane in the mixture. Finally *iso*octenes are separated from the normal butane and unconverted butenes, and the last two products are combined with the *iso*butane fraction and subjected to alkylation to form a substantially saturated gasoline from the butene and *iso*butane.

G. Alleman. U.S.P. 2,288,769, 7.7.42. Appl. 5.9.36. Method of oxidizing aliphatic hydrocarbons by passing oxygen-containing gas into the hydrocarbons while heating to 120–200° C., and substantially lowering the temperature during the latter part of the oxidation.

S. L. Bass and E. F. Graves. U.S.P. 2,291,442, 28.7.42. Appl. 22.11.38. Preparation of an internal-combustion-engine fuel consisting of a liquid hydrocarbon fuel having a viscosity below 50 sec. Saybolt Universal at 100° F. to which has been added 0·1–5·0% by weight of an aromatic ester of phosphoric acid containing at least one aromatic radicle having a molecular weight of 100 or more. H. B. M.

Detonation and Engines.

1016. Patents on Detonation and Engines. Standard Oil Development Co. E.P. 546,780, 30.7.42. Appl. 12.8.40. Method of fueling an internal-combustion engine using a solid injection fuel system, by feeding a liquid fuel to the engine from a main fuel supply tank and increasing the cetane number of at least a portion of the fuel, after it leaves the supply tank, by contacting it with a separate supply of a solid and at least partially soluble ignition promoter.

E. M. Marks. U.S.P. 2,285,294, 2.6.42. Appl. 11.6.40. Process for reforming naphtha to improve its anti-knock quality. The naphtha is contacted under reforming conditions of temperature and pressure, with a catalyst consisting of aluminium oxide and an alkali metal borate. H. B. M.

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Geology and Development.

1017.* Stratigraphy and Insoluble Residues of Madison Group (Mississippian) of Montana. L. L. Sloss and R. H. Hamblin. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, **26** (3), 305–335.—The western part of Montana, where the Carboniferous Limestone is concealed by overthrusting, belongs to what was once part of the Cordilleran geosyncline. The rest of the State is underlain by a continuous sheet of Madison Limestone (Lower Mississippian), 500–1200 ft. thick, the greatest development being found in a broad west–south-west–east–north-east basin which runs into North Dakota. Faunal evidence indicates a Kinderhook and Osage age, and that the early Mississippian sea of Montana connected with that of the Mississippi Valley.

The lower division of the Madison is the Lodgepole formation. At the bottom of the Lodgepole is the Paine member (180–320 ft.), consisting of shales and thin bryozoan limestones with chert lenticles. The shales, which seem to thin eastwards, have conodonts much like those in correlative Chattanooga and Woodford shales. The black fissile Chattanooga facies covers an area 2000 ml. long, but is treated as having been deposited in shallow, often more or less isolated, basins. Above the Paine is the Woodhurst member (270–340 ft.), with massive limestone beds that may show abundant crinoidal debris above channelled surfaces.

The upper division of the Madison is the Mission Canyon (330–700 ft.), of pure, very massive limestone. In the Little Rocky Mountains current-bedding is common in beds mainly of calcite grains—*i.e.*, limestone sand produced by erosion, and less frequently oolites. About the middle of the Mission Canyon there is a chert horizon. Intense solutioning has taken place partly in the Palæozoic, partly in pre-Jurassic time, when a karst topography developed and "solution breccias" were formed by collapse of cavern roofs. The Mission Canyon represents the greatest extension of the Madison sea, and, except for clastics near the emerging range of the Uinta-Front in Southern Wyoming, is almost purely calcareous.

In middle Valmeyer time the sea shrank into the centre of the Montana basin, where evaporites were deposited, while erosion went on round the sides. Marine spreading before and during early Chester time provided the Big Snowy sediments, but until late Chester or early Pennsylvanian time a narrow tongue of land persisted along the southern border of Montana.

Petroleum reservoirs have so far been found only in the Mission Canyon formation. In the Kevin–Sunburst field most of the oil is from the top 10 ft. (1) in a loose rubble of eroded limestone pebbles and silts, locally known as the "Ellis Sand"; (2) in layers with cherts and silicified fossils from which the calcite has been dissolved out; and (3) where there has been differential solution of calcite from partly dolomitized limestone. The Turner Valley field, Alberta, yields from three porous zones in the upper 400 ft. of the Mission Canyon (= Rundle) where W. D. C. MacKenzie has claimed that porosity is everywhere associated with dolomitization. The dolomitization often follows stratigraphical horizons, and it is suggested that it may have been controlled (1) by the easier entry of ground-water in areas of much jointing and fracturing, and (2) by more ready circulation of water through cross-laminated layers of calcite sand which are more porous than normal limestone.

The Paine group gives a residue of clay galls bearing dolocasts; also tan and grey chert with silicified bryozoa. Woodhurst residues contain abundant silicified crinoid columnals and brachials, brachiopod shells and spines, echinoid spines, hexactinellid spicules; some zones have numerous sub-rounded quartz grains; oolitic grains and oolitoid clusters are common. Mission Canyon residues do not exceed 2% of the sample, and yield quartz and white chert grains with accessory magnetite, tourmaline, ilmenite, zircon, garnet, biotite, and muscovite; silicified fossils occur in a few zones; one zone has clusters of quartz crystals.

Points of distinction between these remainders and those of other limestones in Montana are indicated. Residues of the Bighorn dolomite (Ordovician) resemble those of the Mission Canyon, but occur in much greater amount. A. L.

1018.* Stratigraphy of North Dakota. Virginia H. Kline. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, **26** (3), 336–379, with bibliography and map.—Only the south-west part of North Dakota is free of glacial drift, which in other areas includes three stages—one of pre-Wisconsin age, and two belonging to the Wisconsin. This sum-

mary is, therefore, based on river sections and well-cores. Several well-logs of type sections are quoted at the end of the paper.

Pre-Cambrian gneiss, granites, and quartzite are found beneath the drift of the Red River valley; and the surface of this pre-Cambrian complex slopes down westward at least 25 ft./ml. Some superjacent sandstone may be Cambrian, but there is no evidence of this system farther north in Manitoba. The Ordovician starts with sandstone and grey to brown shales which pass up into red shale, limestone, and dolomite. The Silurian is mainly limestone and dolomite. The Devonian, present over nearly the whole State, is of red to grey shale and cream limestone.

The Mississippian, recognized only in Kamp No. 1 well, Williams County, is over 2800 ft. thick, with limestone and dolomite followed upwards by red shale and halite, and topped by black and grey shales with coal. The Mississippian is restricted to the western half of North Dakota, as also are red shales and purple sands of the Pennsylvanian and Permian, salt-bearing strata of the Trias, and the Jurassic, which includes Sundance–Ellis shale, sandstone, and limestone, and the Morrison variegated shale.

The Cretaceous, covering nearly the whole State except the Red River valley, dips westward at 10 ft./ml., its basal unconformity decreasing in the same direction. It begins with Lakota white sandstone with some shale and abundant pyrites, succeeded by the Fuson shale break with lenticular limestones, and the Dakota sandstone, which is here a thin bed (0–90 ft.) of micaceous, loosely cemented, white sandstone containing associated pyrites, gypsum, and lignite. A few foraminifera are found in the Dakota that also appear in the overlying Benton dark clays which are distinguished by large selenite crystals and much free sulphur. The Benton fauna includes *Lenticulina* sp., *Gümbelina globosa* (Ehrenberg), *Globigerina cretacea* d'Orbigny, etc.; and at Devil's Lake and Langdon the number of these abruptly increases at horizons respectively 255 ft. and 280 ft. above the top of the Dakota sandstone.

The Niobara "cement rock"—argillaceous limestone—has the same fauna as the Benton plus *Planulina kansasensis* Morrow, *P. complanata* (Reuss), *Gyroidina nitida* (Reuss). It is also characterized by decrease in number of *Globigerina cretacea*.

The Pierre (up to 2600 ft.) is thicker than the rest of the Cretaceous. It begins with black shales, associated locally with fuller's earth, which weather in plastic fashion like the Benton, but contain fish-scales instead of foraminifera. Higher up are grey shales with zones of concretionary ironstone. Thin limestones are common, and the calcareous shale at Valley City may be equivalent to Chalk of the Upper Gregory in South Dakota.

The Fox Hills group at the top of the Cretaceous is of cross-bedded sand with ironstone.

Tertiary deposits occur in the western half of North Dakota. The Lance formation begins with the Hell Creek grey or brown—"somber"—continental beds of sand, shale, and limestone. In these, gravel and lignite are rare, but there are huge disc-like and log-like concretions of sandstone, and in addition ironstone nodules. The Ludlow formation is similar. But the Cannonball at the top of the Lance is marine and has massive sandstone and interbedded sand and shale.

The Fort Union is of white clay, sandy clay, and sandstone, all of fresh-water origin. It contains thick beds of lignite, and sometimes near the junction of Upper and Lower Fort Union these have caught fire so as to give rise to "clinker." The sands are less coarse and less cross-bedded than those in the Lance. The White River beds are lacustrine and fluvial clays and sands.

There are no important unconformities in the Cretaceous and Tertiary. A. L.

1019.* Pre-Cretaceous Topography of Western Edwards Plateau, Texas. E. H. Jager. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, **26** (3), 380–386.—R. T. Hill first recognized the importance in Texan geology of the surface of pre-Cretaceous erosion, which he named the Wichita palæoplain. After deposition of the Trias, erosion was active during Jurassic and earliest Cretaceous time, until the advance of the Comanche sea laid down the basal Trinity sands. L. D. Cartwright in 1932 published a detailed structural contour map of the old peneplain in the eastern part of the Edwards Plateau, and indicated probable islands in the Trinity sea.

In the western Edwards Plateau, Jager demonstrates a topographical elevation in Upton County, and east of it a gentle slope to south-east at 8–10 ft./ml., reduced to

6 ft./ml. in a southerly direction in Crockett County. An apparently pre-Comanche valley crosses the old peneplain, following the course of the Pecos river. This depression was ascribed by Morgan Roberts to solution of subterranean salt-beds. But Jager thinks the only area with possible sink-hole or "flash" topography, due to solution of Castile evaporites, is that in Blocks 16 and 18 of the University Lands, in Pecos County.

South of the Pecos river the ancient surface rises south-westwards at 25 ft./ml., but soon this is changed to a southward slope of 60 ft./ml. as the Cretaceous thickens into the Rio Grande embayment.

Because of planation before the deposition of Triassic terrestrial beds, Permian structures like the Sheffield channel do not show up well in the pre-Cretaceous features.

Even distribution of the 150-ft. Trinity (= Paluxy) sands and shales indicates few Comanche islands.

Regional uplift has affected the whole of the western Edwards Plateau, and the Fort Stockton plateau has been tilted eastwards. A. L.

1020.* Los Angeles Basin Earthquake of October 21, 1941, and its Effect on Certain Producing Wells in the Dominguez Field, Los Angeles County, California. K. M. Bravinder. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, **26** (3), 388–399.—The series of anticlinal oilfields, arranged *en échelon* along the Newport–Inglewood fault line, are regarded as the result of horizontal shearing movements between blocks of the underlying basement. In the October earthquake the epicentre was 3 ml. south-east of the middle of the Dominguez field. The structure here is still growing, and unrelieved stresses, present near the crest of the western block, were released by movement of an east–west fault. The hade of the fault increases towards the surface; and, where the hade is greatest, the horizontal component of movement was at a maximum and damage was most severe to tubing in wells. A. L.

1021.* Patterson Pool, Kearny County, Kansas. M. D. Hubley. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, **26** (3), 400–401.—The Cherokee group (Pennsylvanian) has been added to the producing zones of western Kansas, and production has been carried to a point within 33 miles of the Colorado border. The Patterson sand lies at a depth of 4740–4752 ft. Bottom-hole pressure 1128 lb. Pumping capacity about 3964 brl./day. Gravity of oil 34° Bé corrected. A. L.

1022.* Artinskian Series [U.S.S.R.]. C. O. Dunbar. *Bull. Amer. Ass. Petrol. Geol.*, March 1942, **26** (3), 402–409.—Reasons are given why the Artinskian grits and rudaceous strata (?Permian) should be treated as lateral interdigitating variants of the limestones of the Ufa Plateau on the west side of the Ural Mountains. The view that the detritals are wholly younger than the limestone which might be Carboniferous depends on Tolstikhina's report of *Schwagerina lutugini* in the "Lower Artinskian conglomerates," east of Buloga. This point requires corroboration, but the fusuline in question is not restricted to the topmost limestones of the plateau. The *Guidebook, Permian Excursion, Northern Part, Seventeenth International Geological Congress* (1937), confines *S. lutugini* to a zone well below the middle of these limestones.

A. L.

1023.* Permian of West Texas and South-Eastern New Mexico. P. B. King. *Bull. Amer. Ass. Petrol. Geol.*, April 1942, **26** (4), 535–763.—This monograph, illustrated by geological panoramas and palæogeographical maps, gives an account of sedimentation and correlation of the Permian of West Texas and of South-eastern New Mexico. The Permian is buried in the middle of the basin, but exposed in broad plains on the east and in mountains on the west. Two of the western ranges—the Guadalupe Mountains and the Glass Mountains—are fully described as type sequences. The four series of rocks dealt with are the Wolfcamp (probably Permian), followed by the Leonard, Guadalupe, and Ochoa. The rocks of the Guadalupe Mountains region were laid down near the edge of the Permian Delaware basin, at the margin of which differential rates of subsidence, contrasting salinities, etc., result in complex changes of facies as between a shelf area and a basin of maximum subsidence. At times, along

the line of hinge dividing the two, very interesting reef or " reef-knoll " deposits were accumulated.

On the shelf the Wolfcamp series takes the form of the Hueco limestone, unconformable on Pennsylvanian, but with a transitional Upper Carboniferous–Permian fauna. In the basin it becomes black and shaly.

The Leonard, in places unconformable on Wolfcamp, consists in the marginal area of Victorio Peak limestone, on the hinge of grey " reef-knoll " limestone, and in the basin of black, thin-bedded Bone Spring limestone with shale.

On the margin the Guadalupe begins with an unconformity. In the basin it is mainly sandstone, and the lower member thins out against the Leonard. The middle and upper members change on the shelf into the reef-masses of the Goat Seep and Capitan limestones. Peripherally to these there are finely bedded limestones, and finally the evaporites of the Chalk Bluff formation.

The Ochoa is dominantly of evaporites, mainly anhydrite and salt, with some dolomitic limestones and red beds. Potash salts are mined in three places. There is overlap on the Guadalupe.

Monoclinal flexures on the margins of the basin seem to have moved before, during, and after Permian time, and affected facies distribution, especially in the Leonard. The " reef-knolls " of the Guadalupe are closely related to the margins of the basin. Probably initiated by shoaling, a condition partly of tectonic origin, their growth was maintained by continued greater subsidence of the basin than of the adjacent shelf areas.

Basins and shelves appear to correspond with uplifts and subsidences initiated before Wolfcamp time when the West Texan region formed a foreland—which was gently folded, upraised, and deeply eroded—with reference to a southern geosynclinal which was being compressed to give the Marathon folded belt. Wolfcamp seas spread over the whole area, but from the Leonard onward the trend was towards withdrawal, so that red beds, evaporites, and lagoonal deposits encroached farther into the Delaware basin. The connection of limestone " reef-knolls " with minor marine advances following upon big retirals of the sea may be significant, if the material of these is partly derived by erosion and solution of older limestones. On p. 638 King shows diagrammatically the theoretical relations between reef-growth and subsidence of a basin. When there is no subsidence towards the basin, the reef grows in a horizontal direction. With upward growth of the reef greater than subsidence, the reef takes up successively higher positions towards the centre of the basin. If upward growth is equal to subsidence, the reef ascends vertically. Where subsidence (= marine advance) exceeds reef-growth, the accumulation of poorly bedded limestone takes place at higher and higher levels in positions at a gradually increasing distance from the centre of the basin. For reef-growth King (p. 730) postulates warmer, more agitated water in which calcium carbonate would be less soluble than in the cooler, quieter water of the deep basin. The oxygenated disturbed water would favour food-getting by organisms. Lime-secreting animals and plants would thrive in it, and, on account of its saturation with lime, their shells after death would be safe from dissolution. Limestone barriers formed in such alongshore positions would also prevent sediment from reaching the deeper water. Thus there is evidence of depths of 1000 ft. or more in late Guadalupe time when reef-building was at its acme.

It is suggested that in two instances—at the end of Leonard and at the end of Guadalupe times respectively—the withdrawals of the sea may have been eustatic due to a widespread alteration of sea-level. Either that, or there was broad uplift of the continent over an immense territory. A. L.

1024.* Pseud-Abyssal Sediments. W. G. Woolnough. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 765–792.—The late Neogene has seen great orogenic activity. Continents at present stand much higher out of the sea than during most of geological time. Existing conditions tempt geologists, trained in North Atlantic countries, to misapply Sir Charles Lyell's theory of uniformity of erosional and depositional processes. Woolnough re-propounds that, during certain ages when land was " ultra-base-levelled," accumulation of terrigenous materials contributed by rivers to the sea was subordinate to purely marine deposition upon much-extended continental shelves. Woolnough refers illustratively to the advanced ep-Archæan and ep-Alonkian peneplains of the Grand Canyon, as described by R. P. Sharp, and regards

mechanical erosion (other than by wind) as ceasing when peneplanation is "perfect."

The radiolarian hornstones (Trias or Jurassic) of the Moluccas and Borneo are often intercalated in coarsely clastic beds, so that they can scarcely be of abyssal origin. Nevertheless, they were formed under conditions of (1) reduced transportation of detritus, (2) virtual absence of calcium compounds, (3) presence of soluble silica and probably also of iron-hydroxide and alumina in colloidal form, (4) possible carbonation and low oxygenation of adjacent water, (5) presence of organic acids or bacteria. In the area of deposition required for the radiolarian cherts, benthonic organisms could not exist, calcareous shells were excluded or subject to solution, the dentine on sharks' teeth might be dissolved, and manganese nodules—as in Timor radiolarites—could be formed.

Woolnough suggests all this is possible in fairly shallow waters if on land the ultimate stages of peneplanation and chemical weathering are reached. The red clays of the East Indies are usually associated with basic and ultrabasic igneous masses, which possibly, where exposed to erosion, had lost all their lime. Woolnough tries to explain the absence of current-bedding in his shallow seas by introducing barriers. These would cut off free marine circulation; and toxic bottom conditions can also be ascribed to this circumstance.

Reference is made to K. Andrée (1905), who doubted the deep-sea origin of these East Indian radiolarian rocks and those of the Alpine Trias. The cherts of the Culm may also be a case in point, since along the right bank of the Rhine Posidonia beds and Culm facies are intercalated. The determining factor seems to be one of sedimentation, not of depth. A. L.

1025.* Geology of Honda District, Colombia. J. W. Butler. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 793–837.—The town of Honda is situated on the Rio Magdalena, north-west of Bogota. Here different sedimentary facies characteristic of the Upper and Middle Magdalena Valley regions may be traced into each other, and so be correlated. Three distinct geomorphological sub-provinces occupy north–south belts. Going from east to west, we find:—

(1) The West Slope of the Cordillera Oriental is made up of the Guadas group (Eocene) resting on Cretaceous and overthrust westward upon the Honda series (Miocene), which lies conformably on the Colorado series (Upper Oligocene). The Colorado is of sands with subangular pebbles of quartz and black chert, followed by mottled shales and sandstones, above which a 15-cm. seam of lignite is succeeded 1·5 m. higher up by a 30-cm. fossiliferous bed containing *Corbula*, *Hemisinus* (?), and fish teeth. This marine to brackish assemblage is taken to represent the La Cira zone. Later there are shale, white sand, and coal. Large selinite crystals and yellow halite precipitate occur throughout.

Although amphiboles are practically absent in the Colorado, they are characteristic in heavy residues from the Honda series, in which the Lower Honda (1600 m.) is distinguished by finer texture and by absence of andesitic and dacitic pebbles from the Upper Honda (2400 m.). On a heavy mineral basis correlation is with the Real series. Plants in an outlying patch of Upper (?) Honda, at Falan, include *Bambusium*, *Heliconia*, *Ficus*, *Persea*, *Nectandra*, suggesting a wet tropical environment.

(2) The Llanos of the Magdalena Valley are underlain mainly by alluvial fans of the Mesa formation (late Pliocene or early Pleistocene), up to 350 m. thick, deposited from western mountains upon what may be a syncline of Honda strata produced by intense post-Honda folding. One fan dammed the Magdalena river at the town of Honda, so that, as well as current-swept deposits, some of the beds were laid down under still-water conditions in "Lake Hettner." Trains of boulders are taken as marking stream channels. There is much pyroclastic material from volcanoes of the Cordillera Central.

The succeeding Gualí formation (Pleistocene), 21–33 m. in thickness, is mostly reworked Mesa, and occurs in modern valleys. Although porous like the Mesa, it is more densely colonized by vegetation, since it frequently carries a veneer of alluvium.

(3) The east slope of the Cordillera Central consists of metamorphic and plutonic rocks—Tolima bathylith. From it streams flow into the Llanos.

Earlier authors like H. Stille and J. V. Harrison regarded the Magdalena Valley as a graben. Others have suggested that it is a ramp valley with overthrust faulting

on the west side as well as on the east. While leaving the question open, Butler inclines rather to the view that a pre-Tertiary peneplain embracing part of the Cordillera Central has been tilted eastward. In any case the valley is of tectonic origin, structurally outlined in the post-Miocene rather than late Cretaceous; and erosion was the most important agent in its development between Honda and Mesa time.

A. L.

1026.* **Base Exchange and Sulphate Reduction in Salty Ground-Waters Along Atlantic and Gulf Coasts.** Margaret D. Foster. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 838–851.—In the Gulf Coast plain, if samples are taken down dip towards the sea, the shallow waters in sands are of normal calcium bicarbonate type, but the deeper waters contain instead sodium bicarbonate formed by reaction with base-exchange minerals—glauconite and certain hydrous alumino-silicates—which at the time of deposition, if not subsequently, were subjected to the action of sea-water. The deep waters are typically poor in calcium and magnesium, and also low in sulphate and chloride.

Sea-water is 30–75 times more concentrated than uncontaminated waters of the Coastal Plain, so that a small admixture of sea-water rich in calcium, magnesium, sulphate, and chloride, should produce a notable increase of these constituents. In no case, however, does there appear to be a simple mixture of sea-water and fresh water. Accordingly it is concluded that base-exchange minerals in the sands cannot be in equilibrium with present-day sea-water or with mixtures of sea-water and fresh ground-water. This suggests that the sandy strata have been flushed more or less free of salt-water farther down dip than at present by water having lower *Ca*/*Na* and *Mg*/*Na* ratios, and that base-exchange minerals have removed *Ca* and *Mg* from encroaching sea-water and have substituted sodium.

The poverty of sulphate recalls oilfield waters, and those associated with sulphide in carbonaceous rocks. It is not known to what depths of burial in sediments sulphate-reducing organisms—anærobic bacteria—remain active; or whether inanimate organic matter may play a very slow part in reducing sulphates at low temperatures, although such reduction can take place at 700–1000° C.

Murray and Irvine—*Trans. R. Soc. Edinb.*, xxxvii, 1895—found that water from blue muds of the ocean bottom was lower in sulphate and higher in bicarbonate than normal sea-water. As the calcium content of the water was not above normal, the increase of bicarbonate was apparently due to deoxidation of sulphates by organic matter, and to the carbonic acid thus produced decomposing certain minerals.

Connate waters with low sulphate and high bicarbonate content may have existed in the rocks since the time of formation. This water might migrate seaward as the head of sea-water fell, and later return as the head rose. A. L.

1027.* **1941 Supplement to Sutter (Marysville) Buttes Development, Sutter County, California.** W. Stalder. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 852–856.—The possibilities of the Marysville andesite core with later rhyolite and andesite stocks were recognized in 1932 by Stalder, and since then six wells have been drilled. These have obtained commercial quantities of gas (1) in baked and cracked shales adjacent to the core and (2) in lateral tilted sands. Cretaceous sediments, close to the core, dip at as much as 75°, and this is attributed to the initial andesite intrusion (see also C. B. Hunt, *Bull. A.A.P.G.*, February 1942).

In Ione sandstone, and Butte gravels (Eocene), ¾ mile south of the core, dips of 90° are found, where beds already steeply inclined were pushed to a vertical position by a chonolith, 2000 ft. thick, which juts out sideways from the core.

Well No. 2 met diorite at 7014 ft. It is not known if this forms part of an isolated intrusion or is part of a basement complex. In the former case, Stalder suggests that oil may yet be drilled at 13,000–14,000 ft. in a continuation of the Horsetown oil-sands (Cretaceous), known from their outcrop on the west side of the Sacramento Valley.

All the gas at Marysville Buttes has a gasoline odour, but cannot be classified as a wet gas. A. L.

1028.* **A Silurian Graptolite Zone in Crane County, Texas.** C. E. Decker. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 857–861.—From black shaly limestone at

9340 ft. down, in University Lands, Block 31, Crane County, Texas, *Monograptus vomerinus* (Nicholson), indicating a Silurian age, and a conodont like *Gyrognathus primus* Stauffer, have been discovered. One specimen of the graptolite suggests approach to *M. vomerinus basilicus* Elles and Wood, which is also found in the Chicago area. *M. vomerinus* appears in the Upper Lockport shale (Niagaran), at Blue Island, Illinois, and has a long range in the Wenlock of Britain. It also occurs in Bohemia and Australia. A. L.

1029.* Test on Cedar Creek Anticline, South-Eastern Montana. O. A. Seager. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 861–864.—A 9680-ft. boring, completed in October 1941, of which an outline log is given covering all formations from pre-Cambrian to Cretaceous, with the exception of the Silurian and Devonian, which are absent, provides a valuable check-up on the underground stratigraphy of Montana, about which—as in the Baker–Glendive anticline—there has been confusion. A. L.

1030.* Selected Annotated Bibliography on Oil-Field Waters. L. C. Case and others. *Bull. Amer. Ass. Petrol. Geol.*, May 1942, **26** (5), 865–881.—This bibliography covers Canada, Rumania, Russia, Trinidad, and Venezuela, as well as the U.S.A., but does not include references to the Water Supply Papers of the U.S. Geological Survey. Papers by about a hundred different authors are briefly outlined. A. L.

1031.* Wildcat Drilling in 1941 with Comments on Discovery Rate. F. H. Lahee. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 969–982.—A wildcat is a hole drilled completely outside the boundaries of pools already developed, and far enough from producing areas to be a test of new possibilities. "Semi-wildcats" are described by Lahee as wells drilled in known fields for exploration below established oil horizons. These are excluded from the present account.

Wildcats completed in 1941 in twenty-four States of the U.S.A. numbered 3264 against 3038 in 1940. Average depth increased from 3339 ft. to 3559 ft. in the whole area; and from 4209 ft. to 4372 ft. in the southern States.

Of wildcats located on technical advice of a geological and/or geophysical nature 471 were successful for oil or gas, and 1928 were dry. Thirty wells sunk for non-technical reasons were successful, against 771 that failed, two producing and sixty-two dry sites were selected for no ascertainable reason.

Wildcatting is on the increase in California, Texas, Kansas, Louisiana, and Illinois; but decreasing in Michigan and Mississippi.

Five times as many wildcats result in discovery where professional advice has been sought as where the drilling is for non-technical reasons. In 1939 the figure was between 1·5 and 2·2 times. Deep drilling has increased the demand for geological help. A. L.

1032.* Developments in 1941, Gulf Coast of Upper Texas and Louisiana. O. L. Brace. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 983–990.—The unfavourable trend in Upper Texan coastal discoveries, which set in about 1937, continued in 1941. Fifteen new areas were brought into production, but the new reserves are certainly smaller than those of ten areas discovered in 1939.

Coastal Louisiana had a reasonable year with seventeen new productive areas, although none of these is outstanding.

Activity on the Wilcox (Eocene) trend has been successful in Texas, but not in Louisiana. The new Magnolia field in Montgomery County, Texas, may have big reserves. A. L.

1033.* Developments in South-Eastern United States in 1941. U. B. Hughes. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 991–999.—The trends in the south-eastern U.S.A. are: decrease of wildcat and geophysical activity, inception of core-drilling programmes by eight major companies, continuation of the leasing programme in South Mississippi and its extension into Alabama and Florida, and gradual eastward shifting of exploration.

A 12,399-ft. hole in south-western Alabama has penetrated the Buckner limestone,

Smackover limestone, and Eagle Mills formation of Jurassic age. The Smackover produces oil in Arkansas and evidently extends across the Mississippi embayment.

The Tinsley oil-pool, Mississippi, has been outlined, and a new sand, the McGraw, has been found in the base of the Eutaw (Upper Cretaceous).

Four new salt domes are reported. A test of the Wilcox (Eocene) on top of the King's dome, Warren County, which proves to be uneconomic, shows low-gravity asphaltic oil and water, suggesting possibilities in the Wilcox of the region.

Production for 1941, entirely from Mississippi, was made up as follows: Tinsley field (327 wells), 15,279,323 brl.; Pickens field (3 wells), 209,997 brl.; Cary field (1 well), 3758 brl.; Sharkaburg (1 well), 7753 brl. A. L.

1034.* Developments in South Texas During 1941. L. B. Herring. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1000–1006.—Prorating of casing caused comment, but necessary materials were available until the last few days of 1941. Production remained steady at 81 million brl., but the proportion of yield to that of the U.S.A. as a whole, fell from 6·29% to 5·8%. Reserves added by newly discovered areas were small, except for completion of good wells in Wilcox sands, in La Salle and Bee Counties.

Electrical logging having led to a neglect of the saving of samples, geologists are now having to re-educate drillers in the value of palæontological data.

The Vicksburg flexure, trending north-east parallel with the coast, and evidenced by down-dip thickening of Lower Frio and Vicksburg beds, can be measured through thousands of feet. Closely associated with it are anticlines, faults, unconformities, and sand wedges, all contributing as traps for gas and oil. Traceable from Starr County, on the Rio Grande, to Jackson County, on the Gulf of Mexico, it is the outstanding structural feature of South Texas.

Only one new gas-recycling unit was started, but there is rebuilding of old plants to stabilize and retain the butanes and propanes. These are now in huge demand for synthetic rubber and 100-octane gasoline. A. L.

1035.* West Texas and South-Eastern New Mexico Development in 1941. West Texas Geological Society Committee. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1007–1039.—In 1941 West Texas saw greatest development since 1937. 2325 wells were drilled, of which 2190, or 94%, were producers. The Slaughter field in the San Andreas zone of the Leonard (Permian) was the most active, with 678 new wells over a proved area of 57,000 acres.

Drilling in the pre-Permian was of prime importance in the Abell field, Pecos County, where 40 wells were completed as producers in the McKee sand of the Simpson (Middle Ordovician). In addition, 7 yield from the Waddell sand of the same series, and 1 from the Ellenburger (Cambro-Ordovician), which is more productive elsewhere, *e.g.*, in the Apco Pool, Pecos County, and in Reagan and Crane Counties.

In Todd field, Crockett County, discovered in March 1940, 6 new producing wells have been sunk in Strawn crinoidal limestone (Lower Pennsylvanian).

In south-eastern New Mexico there was a decline of 31·5% in the number of wells drilled in 1941, and the proportion of dry holes rose to 70 out of a total of 371. The most active field was the Maljamar, with 61 new wells, only 3 of which were dry. There were four new discoveries in the Yates, Seven Rivers, and Grayburg zones, all of which belong to the Guadalupe series (Permian). A. L.

1036.* New Developments in North and West-Central Texas, 1941. North Texas Geological Society. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1040–1049.—In 1941, 1972 oil-producing wells were drilled as against 1130 dry holes. There were 53 new gas wells.

Wichita County leads with 438 new oil-wells against 119 dry. Since the value of the Ellenburger (Cambro-Ordovician) in the K.M.A. area was discovered in April 1940, 116 wells have been sunk into it, and of these 104 are flowing, 9 are pumping, and 3 are dry. The total production of Wichita County for the year was 15,702,000 brl. Archer County was next, with 7,585,000 brl.

As well as in the Ellenburger, discoveries have been made in Mississippian limestone; in the Bend, Caddo, Strawn, Canyon, and Cisco groups of the Pennsylvanian; and in

the Wolfcamp (probably Permian). The only virgin producing horizon discovered is the Dothan limestone (Permian) of Merkel pool, Taylor County. A. L.

1037.* Developments in East Texas During 1941. F. R. Denton and R. M. Trowbridge. *Bull. Amer. Ass. Petrol. Geol.*, June 1942, **26** (6), 1050–1057.—Increase of exploratory tests resulted in the finding of three new oilfields. Two produce from the Woodbine, base of the Gulf series (Upper Cretaceous), and one from the Rodessa zone of the Lower Glen Rose, middle of the Trinity (Lower Cretaceous).

In the Hawkins field, the major 1940 discovery, 243 oil-wells, 3 gas wells, and 8 dry holes were completed. There is extensive faulting and probably over 900 ft. of closure on top of the Woodbine sand. One marginal hole reaching the Paluxy (Lower Cretaceous) has proved dry. Pipe-lines with a daily capacity of over 40,000 brl. have been laid to the field.

Altogether 1145 wells—202 dry—were drilled, as compared with 659—114 dry—in 1940. A. L.

1038.* Colombian Area's Outlook Improved by Well Showing. Anon. *Oil Wkly*, 31.8.42, **106** (13), 48.—Tres Bocas 3 on the Barco concession has given oil at the rate of about 170 brl./day. This well lies 3 ml. east of No. 2-A, a 400-brl. producer recently completed.

Casabe 5 on the Yondo concession in the Magdalena Valley is reported to have yielded oil at the rate of 800 brl./day on test, and constitutes the fifth consecutive producer in this area. G. D. H.

1039. An Engineering Study of the Magnolia Field in Arkansas. H. F. Winham. *Petrol. Tech.*, Sept. 1942, **5** (5), A.I.M.M.E. Tech. Pub. No. 1491, 1–20.—The surface structure at Magnolia was defined as early as 1921, and the first wildcat was drilled in 1923. Several shallow wells followed which were not taken below the Upper Cretaceous and did not find commercial oil or gas showings. In 1935, the lowermost Glen Rose was penetrated, again without showings. Seismic work preceded the drilling of the discovery well, which went to 6325 ft. without finding commercial production. This well was deepened to the Smackover and eventually completed as a producer at 7647–7652 ft. and 7664–7669 ft. in 1938. It lies near the northern margin of the pool. Development spread east and west until 87 wells were producing at the end of 1939, after which development slackened. A 40-acre spacing was adopted. Three strings of casing are set in all wells.

The gas–oil contact was at 7140 ft. below sea-level, and the oil–water contact at 7318 ft. The gas was cemented off, and each well was tested on completion to determine that the gas–oil ratio was below 2000 cu. ft./brl. An active water drive was expected and was found. The wells were cored and tested thoroughly for permeability and porosity. Impervious streaks which would prevent vertical migration were found in the 300 ft. of reservoir rock. The casing was perforated at the permeable streaks, working from the lowest upwards and plugging when water encroached.

From the Upper Cretaceous all the beds of Eagle Ford or Woodbine age are missing, and from the Comanchean nearly 2500 ft. of Washita–Fredericksburg and Upper Glen Rose strata have been eroded. Below the Cretaceous are beds which may be Jurassic (Buckner, Smackover, and Eagle Mills). Production at Magnolia has been found only in the Smackover, although shows have been reported and tested in the Glen Rose and Cotton Valley. The Smackover lime consists of dolomitic shale, oolitic limestone, and crystalline limestone, with the oil in the oolitic limestone, the greatest recorded thickness of which is 340 ft.

The Smackover lime structure is an east–west anticline. The average northerly dip is 6½°, the southerly dip 4°. Production begins about 30 ft. down in the Smackover lime, and covers an area estimated at 4494 acres, with the maximum measured structural relief 372 ft. On the south flank is an upper porous and permeable streak which is separated in its upper part from the main producing zone, and this contains a secondary gas-cap. This porous zone extends to the northern flank.

The producing horizon has an average porosity of 18·5%, 20% of connate water, and permeability ranging 0–16,000 millidarcys, with an average of 1500 millidarcys. There is a possibility of some shallow production from the Rodessa, Cotton Valley,

and Travis Peak. The oil averages 39° A.P.I., and may have 30–400 lb. of salt/1000 brl. It has a shrinkage of 34%.

The total output was allowed to reach about 21,000 brl./day, and in December 1941 the allowable was about 165 brl./day/well. Efforts have been made to equalise the bottom-hole pressures throughout the field. The original bottom-hole pressure was 3465 lb./in.²; it had fallen to 3129 lb./in.² in December 1941, when 18,377,000 brl. of oil had been obtained from 116 wells. The original gas–oil ratio was 700 cu. ft./brl., and the present ratio about 889 cu. ft./brl. All the gas is processed (about 17,000,000 cu. ft./day), and yields about 3·1 gal. of gasoline/1000 cu. ft. The original reserves are conservatively estimated at 180,000,000 brl., giving 455 brl./acre-ft. The water has advanced, some wells producing considerable amounts of water. The majority of the wells may have a life of 10–15 years. G. D. H.

1040.* Trenton Pay Revives Interest in Western Part of Basin. H. E. David. *Oil Gas J.*, 10.9.42, **41** (18), 77.—The Illinois Trenton consists of the Kimmswick, Plattin, and Joachim formations in the south, and the Galena-Platteville in the north. The Kimmswick, due to its tightness, gives only a little oil. At Dupo the Trenton is much more permeable, but the eastward extent of this type of Trenton is unknown because of the lack of exploration.

Early in May 1942 a "Trenton" limestone strike which opens up several hundred square miles for exploration was made at St. Jacob. Ten wells have been completed in a pay having a maximum thickness of 45 ft. The wells gave 80–120 brl. of oil/day before acidization, but are reported to have potentials of 500–1000 brl./day after acidization. None of the wells has gone right through the Trenton, which lies about 2317 ft. deep, with the pay zone 33 ft. below the top of the Trenton. The field, which is on a south-trending anticline with a dome, may cover at least 1000 acres. Streaked saturation has been found in the Trenton of St. Clair County, and this strengthens the belief that several additional Trenton oilfields will be found on the west rim of the Eastern Interior Basin.

The term "Trenton" as applied to Ordovician limestones in Illinois is incorrectly used. The Trenton limestone of Middle Ordovician age is a limestone series found in New York and eastern Canada. When oil was found in Ohio in a limestone of almost the same age on the crest of the Cincinnati Arch, the older term was applied to it. During the first Illinois play following the discovery of oil on the La Salle anticline, the structural similarity of this feature to the Cincinnati Arch led to the hope that "Trenton" oil would be found, and the term came into use in Illinois.

G. D. H.

1041.* The Problem of Petroleum Reserves in the United States. Part I. J. H. McCammon. *Oil Wkly*, 14.9.42, **107** (2), 17.—The A.P.I. estimate of proved reserves on 1st January, 1942, was 19,589,296,000 brl. of oil, the combined reserves of seventeen fields accounting for 43% of this total. At present petroleum supplies almost a third of the U.S. mechanical energy, and it serves as a raw material for many products. The full extent of its usefulness has not yet been reached. The demand for petroleum has increased phenomenally, while the relative importance of individual fields has shown a sharp decline, and although proved reserves are increasing, it is questionable as to whether it is possible to maintain a production in excess of a demand not limited by high prices.

In most years since 1859 the additions to reserves have exceeded the production. Lahee's analyses of the effectiveness of American exploration show that while more and deeper wildcats have been drilled, less oil has been found in recent years excepting 1941. Pratt uses a rather different method of analysis, and also indicates a downward trend since 1936. The number of dry holes per major field has risen markedly. Lahee attributes the falling discovery rate mainly to the growing difficulty of finding new geological traps for oil. The remaining undiscovered reserves he considers as largely either in unexplored regions, in deeper unreached reservoirs, or in stratigraphical traps seldom locatable by surface observation.

Geological conditions for oil formation have been very favourable in Texas, and so it now provides 40% of the U.S. output, and possesses half of the reserves. Nine fields in the Upper Gulf Coast have 60% of the reserves of that district. No deep-seated dome with major closure has been found since 1937, and the increases in reserves

have been mainly from extensions to known fields. In the Yegua there is a zone of potentially most petroliferous sands, and structural traps within this zone have proved most prolific. Gradational up- and down-dip sedimentary changes limit the favourable zone. Subsurface data indicate that no major reserve will be established by deeper drilling on the large non-piercement type structures of the deeper coastal zone. The main productive reserve of each of the few non-piercement domes is so far limited to only one formation. Although the number of new discoveries has increased in recent years, their aggregate magnitude has declined. Down-dip the Wilcox sands are said by Brace to be relatively poor, whereas up-dip the unfavourable factor is lack of structure.

West Texas has 13% of the national reserve, 70% of it being provided by seven fields. On the basis of the wells drilled this has been the second most active area of exploration. The Ordovician production has not been comparable to that of the Permian. Virgin territory in West Texas is diminishing rapidly. The Central Basin Platform has now been fairly well outlined, and much effort has been expended in searching for production between established fields on this uplift. The Delaware Basin has so far yielded only small fields, and major structures are believed to be absent, while production from the pre-Permian seems unlikely because of the suggested great thickness of Permian in this basin. The major West Texas reserves are trapped by structures along the positive areas.

During recent years no outstanding fields have been found in the other producing areas of Texas. G. D. H.

1042.* Typical Oil-Field Structures : Fault-Line : Luling and Powell Fields, Texas. Anon. *Oil Gas J.*, 17.9.42, **41** (19), 32-B.—The northern and western part of Texas has remained above sea-level except locally and for brief intervals since the end of the Palæozoic, while the coastal plain sector tilted south and east throughout the Cretaceous and Tertiary. Between these two areas is a curved hinge-line, the Balcones-Mexia system of parallel faults, along which the downward movement was intensified. Most of the faults are normal, those of the Balcones system dipping south, and those of the Mexia system dipping north. Oil accumulated on the south, up-thrown side of the Mexia system, at high points where the reservoir rocks are cut by the faults. In the down-faulted block between the two fault systems a little oil has been found on local structures, the accumulations bearing no relation to faults.

At the northern end of the Mexia system oil is in the Lower Cretaceous Paluxy sand; in the Mexia district the basal Upper Cretaceous Woodbine sand is the chief pay; and in the San Antonio district the Lower Cretaceous Edwards lime is the main pay, with some oil in the Georgetown, Buda, Austin Chalk, and Taylor Marl. All the production is related to local or regional unconformities. Any horizon which produces on anticlines or domes in any part of this region is a potential pay where it is truncated up-dip by a fault.

There is evidence of up-dip migration of oil in the reservoir horizons until it is stopped by a fault. Oil is generally believed to have been formed near to the horizon in which it now occurs. At many points the oil is in part of a local slight dome or anticline broken by a fault.

The discovery of the minor structures traversed by faults depends mainly on the discovery of the fault-line and its projection downwards to the producing horizon. The seismograph and gravity surveys facilitate the location of the faults.

Four maps and two cross-sections are included. G. D. H.

1043.* Many Deep Pays are Found in Montague County Campaign. R. Ingram. *Oil Gas J.*, 17.9.42, **41** (19), 68.—This year a 7000-ft. wildcatting campaign began in Montague County in the northern part of the Fort Worth basin. A normal Ordovician section has been revealed in the deeper parts of the basin, thus giving possibilities of several pay horizons in addition to those already productive nearby. Fourteen deep pools have been opened in Montague County since January 1939.

The Fort Worth basin is bounded on the west by the Bend Arch, on the east by the Muenster Arch, and on the north by the Red River uplift. Early production in North Texas was associated with the regional highs around the basin, and there were a number of large shallow fields. When the shallow areas were largely depleted, deep drilling began, and deep pays were opened in or near the shallow fields. Gradually

exploration extended from the highs into the Fort Worth basin. A normal section of Pennsylvanian and a full Mississippian section were proved, together with the Simpson and Ellenburger. Several oil discoveries followed. Parts of the Mississippian and Simpson are eroded on the surrounding highs. An east–west Ellenburger high was shown to cut across the basin. Most of the deep wells have found production in the Strawn, Smithwick, or Marble Falls, but the Ellenburger is a drilling objective.

Extensive geophysical work has been carried out, and many local structures have been tested.

The pre-Cisco producing horizons of Montague County are listed with the fields, depths, and number of wells. An Ellenburger lime stratum contour map shows the sites of the pools. G. D. H.

1044.* Study Shows Crude Oil Output Moving Up to Correct Under-Estimates. W. V. Howard. *Oil Gas J.*, 1.10.42, **41** (21), 14.—The minimum daily average production in April was 568,000 brl. below that of February, while the demand for crude was only 244,000 brl. below February's demand. The average daily production for the first eight months of 1942 has been 28,000 and 34,000 brl. higher than during the same period of 1940 and 1941. During the first eight months of 1941 refinery runs were low, and an average of 104,000 brl. was added to storage. A reversal of conditions in 1941 caused 55,000 brl./day to be taken from storage. So far in 1942 supplies of crude have almost balanced demand. The refinery runs are down by 147,000 brl. compared with 1941, and imports are down by 83,000 brl. Since February 1942 imports have fallen from 110,000 brl. to zero, and at the same time apparent exports have risen from 79,000 brl. to 169,000 brl. The August refinery runs are 105,000 brl. above the March figure, and 224,000 brl. above the May low.

Data are tabulated for each month since the beginning of 1940 on production, storage, imports, refinery runs, etc. G. D. H.

1045.* Typical Oil-Field Structures : Unconformities : Zenith, Wherry, and Hollow-Nikkel Fields, Kansas. Anon. *Oil Gas J.*, 1.10.42, **41** (21), 64-B.—The Central Kansas Uplift bounds the Anadarko Basin on the north. It was uplifted at various times during the Palæozoic, sometimes possibly together with a much larger area, for some of the unconformities found on the uplift extend over much of the Mid-Continent area. The major unconformity is at the top of the Mississippi limestone. The Uplift was submerged in the Pennsylvanian, Permian, and Cretaceous.

In many of the fields on the Uplift the reservoirs are associated with unconformities. The oldest is the granite wash, then the Arbuckle limestone, Viola limestone, Misener sand, Hunton and Mississippi limestones, basal Pennsylvanian conglomerate, Kansas City–Lansing, etc. At Nikkel and Voshell accumulation is along an uplift dissected by a fault; at Zenith on a nose. Wherry shows evidence of terracing. In many of the fields, especially the larger ones, there are few signs of local structure, and oil accumulation is governed by porosity.

Many of the fields are shallow with numerous pays, and so much drilling has taken place, mainly during the last ten years. The most effective method of discovering new fields has been the exploration of minor structural irregularities on subsurface key beds, for most of the records are modern. Random drilling has proved of considerable value.

Stratum contour maps and cross-sections of some of the fields are included. G. D. H.

Geophysics.

1046.* Geophysical History of Darrow Dome, Ascension Parish, Louisiana. J. B. Eby and T. I. Harkins. *Petrol. Tech.*, July 1942, **5** (4), A.I.M.M.E. Tech. Pub. No. 1495, 1–8.—The Darrow salt-dome is circular and rises to within 4625 ft. of the surface. Its diameter is about 4800 ft., and the cap-rock is less than 75 ft. thick. Some oil has been obtained from Miocene sands above the cap-rock, but most of the oil comes from a narrow band of wells on the east and south flanks in Miocene beds at 5670–5840 ft., and in Oligocene beds at 6890–6985 ft., 7028–7060 ft., and 8260–8270 ft.

As a result of repeated refraction shooting and gravity work in 1927 and early 1928, the impression persisted that Darrow was a dome, but it was not defined. Early in

1927 a refraction shooting report suggested the existence of a dome-like uplift in the deeper beds, but the investigation showed only very slight disturbance. In March 1928 torsion balance and refraction shooting pictures appeared, the former showing several closing gravity isogals, and the latter one closing refraction line, but neither gave clear-cut positive evidence of a salt dome. Two wells drilled because of lease considerations did not show the occurrence of a dome.

In 1929 reflection shooting began. This was difficult because of the soft surface alluvium, and because the beds several thousand feet deep were soft, lenticular, and without good reflecting horizons. Moreover, it was not then known that there were very steeply dipping beds. Detectors were set up first on one side of the shot-point and then on the opposite side, the first lines being almost north–south and on the south flank of the dome. The reflections on the northern line actually showed less time for the far detector than for the near one, and on the south line there was a much greater difference in reflection time between the near and far detectors than is normal for the overall time, a feature which can only be due to a steep southerly dip of the reflecting horizon. An effort was made to correlate all the reflections obtained with the aid of differential times, and this proved successful. No deep reflections were found round the top of the dome. The first well drilled after completing the reflection picture found Miocene oil at 4025–4035 ft. and salt at 4627 ft.

Reflection dip shooting on the Gulf Coast was initiated at Darrow, and proved successful. Both the torsion balance and the refraction seismograph gave some, if not satisfactory, dome indications, in spite of the unfavourable conditions.

G. D. H.

Drilling.

1047.* Cements for Oil- and Gas-Wells. Part I. L. C. Uren. *Petrol. Engr*, August 1942, **13** (12), 23–26.—The subject is first treated historically. The chemical and physico-chemical properties of Portland cement are then discussed. From the physical point of view three periods are recognized in the hydration of Portland cement: the so-called "initial set," the "final set," and the hardening period. The changes that characterize these different periods are the result of chemical readjustments that, as explained in the article, require time to achieve. The initial set is said to have occurred when the cement slurry has lost its plasticity and become friable to such a degree that two pieces of a broken specimen when placed in close contact will not unite to form a homogeneous mass. After the initial set has occurred, the cement undergoes a further chemical change, as a result of which it acquires greater hardness until the final set has been achieved. It is arbitrarily defined as that condition when a certain degree of rigidity is attained, as determined by a penetration needle of standard proportions. With most Portland cements the final set occurs in from 2 to 5 hrs. after the initial set. It is of no particular significance in oil-well cementing. Following the final set, further chemical readjustments throughout a period of 28 days result in a gradual increase of strength and hardness. The rôles of accelerators and retarders are described, together with the influence of fineness and grinding. A.S.T.M. tests and A.P.I. tentative code are reviewed.

The influence of deep-well conditions is stressed. Pressures of many hundreds of pounds/in.^{2} are imposed by the well fluid (50 lb. or more/100 ft. of depth). The methods of placement employed require that the neat cement slurry be of such consistency that it can readily be passed through pumps. This ordinarily means that the amount of water used shall be 40% or more of the weight of the cement, and methods of placement often permit of further dilution by the well fluid. In the well the cement slurry is usually contaminated to some extent with mud, and perhaps also with oil. The cement slurry is often maintained in turbulent flow through pumps and pipes for a ½ hr. or more after it is gauged with water. Gas blowing through the slurry after it has reached its intended position in the well may keep it agitated until the initial set occurs. Saline ground-waters from strata penetrated by the well may alter the setting properties of the cement. Certain sulphate waters may make the cement "unsound" after it has set. Permeable formations penetrated by the well may absorb some of the water from the cement slurry. Any of these conditions may seriously alter the setting properties of cement so that it does not perform its intended function satisfactorily. This part of the paper is appended with 35 references.

A. H. N.

1048.* Durability of Cements in Contact with Brines and Chemical Solutions. H. H. Miller. *Petrol. Engr*, August 1942, **13** (12), 50.—Results on durability experiments carried out on 27 currents from different manufacturers under certain controlled conditions are reported. Of all neat cements tested to date, the acid-soluble cement and lumnite cements are the most resistant to salt brines. The resistance of lumnite cement lies mainly in the fact that, because of its low lime content, it hydrates without forming compounds easily altered by contact with brine. The resistance of acid-soluble cement is due mainly to the Puzzolanic reaction of the carbonate with the active lime of the cement to form a new desirable compound.

Cements containing fly-ash are considerably more resistant to brine and salt solutions than those containing other adjuncts as tested. Fly-ash, which is the residue of burnt, powdered coal, was obtained from six different sources and was different mainly in the particle size and carbon content. The proportion of fly-ash used as a replacement for cement varied from 1 to 75% in steps of 1–3–5–10–20–25–30–50–75%. The maximum strength and durability with all cements tested were obtained with 20% fly-ash having a low carbon content of approximately 2% carbon and a surface area of about 2600 sq. cm./gm., although fly-ashes of higher carbon content and with surface areas of 800 sq. cm./gm. and finer showed marked improvement in the resistance to brines. Fly-ashes of moderately low carbon content and a high fineness will form a Puzzolanic reaction, thus improving the quality of the cement. The Puzzolanic reaction in cement is quite complicated, but it is generally accepted that when Portland cement hydrates, certain complex reactions take place, freeing a water-soluble highly reactive lime. It is with this active lime that the silicates of the Puzzolanic materials combine to form a new calcium silicate compound and prevent the formation of a crystalline aluminate type material that is readily acted on by brines.

The behaviour of a cement in oil-well brines depends on the individual characteristics of the cement itself, as different cements will vary in chemical composition, degree of fineness, and water–cement ratio, and on the nature of the brine. The most harmful effects to cement are due to sulphates in the brine, as they act on the aluminate compound. The sulphites are also very hazardous, due to their tendency to oxidize and form sulphates. Magnesium chloride in brine plays an important part in bringing destruction to cements. Hydrogen sulphide, which commonly occurs in oil-wells, is very destructive to cement, as it combines with the calcium to form a hydrosulphide. Durability is also definitely related to water-cement ratio, as cements containing low water ratio showed a marked degree of resistance. A. H. N.

1049.* Oil Well Cementing. J. V. Polk. *Petrol. Engr*, August 1942, **13** (12), 82. *Paper Presented before Petroleum Industries Association.*—Channelling and mud-cake removal in cementing operations are discussed. Squeeze cementing is studied at greater length. Squeezing in wells where thief sands, channelling, mud cakes, or other conditions cause the well to " take " the cement slurry under little or no pressure, more than one application of cement is nearly always necessary in order to effect a shut-off, or to attain the pressure desired. Experience has shown that the most effective way is to pump a quantity of cement into the formation, allow it to obtain at least a partial set, and then pump in more cement, allowing each succeeding batch to block-off more channels, until all are closed with cement, which at the end of the job will be " put away " under the desired pressure. This type of operation is known as a " multiple-batch " cementing. The multiple-batch method of cementing is made possible by using the cement retainer with its circulation joint, which provides for the placement of any number of batches of the slurry in one extended operation, in which only one cementing hook-up is used, and only one complete shutdown is necessary to allow the cement to reach its final set before drilling out. A. H. N.

1050.* Big Modern Storage Yard Stresses Prolongation of Stacked Drilling Equipment Life. G. M. Wilson. *Oil Wkly*, 24.8.42, **106** (12), 14–20.—Due to possible difficulties with replacements of parts, special care is being taken in storage of equipment. One large yard is described in detail. Practically every piece of drilling equipment, from the draw-works down to the drilling lime and V-belts, is given a thorough overhaul, repaired if necessary, then placed in storage in such a way that it

will be well preserved, yet be immediately available whenever it may be called upon for further use.

Draw-works, boilers, and mud-pumps are neatly stacked in one portion of the yard in such a way that they will not become separated, thus assuring that all previously-mated pieces will be sent out on a new job as a single unit; a systematic and orderly scheme is carried out in racking and treating of all drill-pipe, drill-collars, and kellys on well-designed pipe-racks; tool-joints are removed and given a thorough over hauling; subs, adapters, fishing tools, and similar small tools are cleaned, painted, and stacked in orderly rows along a specially-designed rack; all sand-lines and drilling lines brought in from the job are efficiently cleaned, lubricated, measured, and generally checked over in a single operation through use of an unusually efficient portable shop-made machine; and all small tanks used for storing drilling mud and water at the well are thoroughly cleaned and painted, inside and out. One of the most recently installed features of the yard, and one the importance of which cannot be over-estimated at this particular time, in view of the current rubber shortage, is a large, cool, air-conditioned "potato cellar," in which are stored rotary hoses, belts of all kinds, cordage, and other such perishable goods.

Wherever possible, except where replacements have been made, every piece of equipment that was part of the original rig is kept together, so that when the unit is once more set up on a location, little time will be lost in assembling and pipe-fitting. When a load of drill-pipe is brought in from a well, it is first cleaned of all mud-cake, both inside and out. The interior surface is cleaned with the aid of an air-nozzle operating under 120 lb. pressure. The nozzle, which effectively blasts out the mud-cake particles, has a long extension handle to permit running it from one end of the pipe to the other.

Following this preliminary cleaning to remove the dried-out mud, the pipe is cleaned inside and out with the steam cleaning unit, particular attention being paid to tool-joints and collar-threads. It is then carefully inspected, and defective portions of threads or collars are marked with a distinctive colour of paint. Red paint indicates that the collar is swelled out, while yellow means that it must be refaced. Many other details of the practices of this yard are given. Each major item of the usual equipment on an oilfield is discussed with the special precautions taken to preserve it for the longest possible time. A. H. N.

1051.* Unitization of Gulf Coast Rigs Saves Time in Moving. N. Williams. *Oil Gas J.*, 17.9.42, **41** (19), 31–32.—The extent to which unitization of equipment and standardization of rig layouts have been carried in some Gulf Coast rig assemblies is reflected by the comparatively short time required for their moves. Even some of the biggest, heaviest, and most complete deep-drilling rigs, having extensive auxiliary equipment specially provided to combat the hazards encountered in deep drilling, can be dismantled, moved, and set up again on another location and be drilling within less than 24 hrs. Such a time schedule is being followed regularly by one major company for its rigs operating in one of the deeper South Louisiana fields.

In this particular field the wells are drilled to depths of 12,000 ft. or lower. The short time required for moving rigs, although the rigs are among the largest and most complete on the Gulf Coast, has contributed to reducing over-all well-time to less than 30 days, and in some cases to as few as 26 days. Drilling and completing wells to such depths in this short time has enabled the company to effect important savings in the development of the field. This is a dry-land field, so that the short rig-moving time is not attributable to employment of barge-mounted rigs. The time required for moving heavy land rigs cannot be reduced to approach that of the drilling-barge rigs used in maritime operations along the Gulf Coast. The latter rigs represent the highest degree possible of unitization, in which all equipment is mounted permanently on barges to be towed intact from well to well.

Photographs illustrate the discussion on unitization. A. H. N.

1052.* Four-Year Operation Shows Merit of Rig Design. H. F. Simons. *Oil Gas J.*, 1.10.42, **41** (21), 33–34.—A review of the record of a rig which has been operating for four years continuously and of its several parts as well as the practices used in drilling with it is given. During the 4 years the rig has drilled 23 wells to depths from 3700 ft. to 5400 ft. for a total of 130,000 ft. This drilling has all been in South Central Oklahoma in the neighbourhood of Ada. This is an area where the formations are as hard or harder than those normally encountered in Mid-Continent drilling.

During the drilling of the 130,000 ft. of hole, the original chains on the rig have never been replaced. This is credited entirely to the use of an individually driven rotary table, which relieves the draw-works chains of unnecessary wear, and at the same time permits complete inspection and repair of the chains while drilling is in progress. The chains are inspected each tour and any missing cotter keys replaced. Worn pins are removed so that there is no play between the pins and the side bars. Lubrication with a light oil helps to prevent chain wear and trouble.

Drill-pipe now in use on the rig is the string which was purchased with the rig, and it has been used to drill every foot of hole. Only one twist-off has been experienced with the pipe, and that was 2 years ago. It is still in good shape, and will be continued in service. The pipe is subjected to as much speed and weight as the average string (75–150 r.p.m. and 10–20 tons). However, it is always broken on a different joint each trip, and the joint-threads and faces are watched for any defects. The wear on the pipe is evenly distributed, as the position of the joints in the string are changed on each well—*i.e.*, the bottom joints on one well become the top joints in the string on the next well.

Details are given of other parts and practices. A. H. N.

1053. Patents on Drilling. W. D. Mounce. U.S.P. 2,296,366, 22.9.42. Appl. 29.12.41. Bore-hole tool with a magnetic device.

A. Muhlbach. U.S.P. 2,296,397, 22.9.42. Appl. 8.5.40. Well-tool adapted to lower or raise apparatus from wells.

W. F. Bates and C. A. Yeatman. U.S.P. 2,296,659, 22.9.42. Appl. 28.12.40. Method and equipment for moving drilling rigs by loading the derrick structure on a trailer unit for transport.

W. L. Horner. U.S.P. 2,296,852, 29.9.42. Appl. 3.1.38. Earth exploration by analysing cores from the sand to predict production of gas, water, or oil whilst drilling.

T. E. McMahan. U.S.P. 2,296,939, 29.9.42. Appl. 5.5.41. Well-bit protector for bits with toothed cutters.

P. Jones. U.S.P. 2,296,996, 29.9.42. Appl. 3.8.40. Directional drift recorder by means of light rays being recorded on a disc after reflection by a concave mirror.

J. S. Page. U.S.P. 2,297,020, 29.9.42. Appl. 15.5.40. Circulating fluid washer for deep wells.

V. V. Shepherd and O. R. Peugh. U.S.P. 2,297,029, 29.9.42. Appl. 2.1.40. Whipstock sleeve for drillable liners in deep-well drilling.

L. Spencer. U.S.P. 2,297,031, 29.9.42. Appl. 23.3.40. Circulation valve for cement retainers.

J. McClinton. U.S.P. 2,297,157, 29.9.42. Appl. 16.11.40. Drill-bit for deep wells.

C. E. Reed. U.S.P. 2,297,192, 29.9.42. Appl. 2.7.40. Earth boring-tool having a toothed cutter on roller bearings.

J. Johnson. U.S.P. 2,297,415, 29.9.42. Appl. 16.6.39. Whipstock consisting of a top and a bottom portion connected by tubular pressure chamber.

E. G. Leonardon. U.S.P. 2,297,568, 29.9.42. Appl. 25.2.39. Spontaneous potential by induction measurements on earth formations.

W. M. Mazee. U.S.P. 2,297,660, 29.9.42. Appl. 27.7.40. Non-aqueous drilling mud having an alkali soap of certain types. A. H. N.

Production.

1054. Oil-Reservoir Behaviour Based upon Pressure-Production Data. H. C. Miller. U.S. Bur. Mines. Report of Investigations No. 3634. April 1942.—It is pointed out in this report that the daily production of crude oil in December 1941 showed

an increase of 16% over the figure for 1940, due to a combination of maximum civilian demand and rising defence requirements. So long as the war lasts it is essential to maintain a steady and adequate supply of petroleum. To do this, maximum efficiency of oil recovery from underground reservoirs must be achieved. Moreover, any producing method which jeopardizes total ultimate recovery must be regarded as conflicting with the best interests of national defence.

It has been found that some of the efficiency of recovery of oil from reservoir sands and rocks is sacrificed if the oil and gas are withdrawn too rapidly. Proration has proved the advantages to be derived from shortening the time during which gas expansion is an important factor in oil production, and controlling production so that oil recovery is the result of water-drive. Further, since the rate of withdrawal of oil and gas from water-drive reservoirs in which the oil is saturated with gas determines whether the oil moves to the well as a result of gas expansion, water-drive, or a combination of both, there is need for a method of determining the relative importance in oil recovery of each type of drive.

This report gives details of a graphic method for representing reservoir-pressure and oil-production data. The cumulative decline of reservoir pressure (in pounds per square inch) is plotted as ordinates on a logarithmic chart against cumulative oil recovery (in barrels) as abscissæ. Thus the relation between cumulative decline of reservoir pressure and cumulative recovery can be plotted on a logarithmic chart by straight lines for large increments of liquid recovered. For some reservoirs one or two and for most reservoirs not more than three or four inter-connecting straight lines will exhibit the pressure decline–oil recovery relations for the entire producing life of the well. The lines have different slopes, and the slope angles, when studied in conjunction with the physical characteristics of the oil and the type of reservoir, are capable of revealing whether the source of energy driving oil through the sands and porous rocks to the wells is the result of gas expansion, natural water-drive, or a combination of both.

The author does not suggest that the method of plotting pressure-production data will permit comparison of the oil-recovery efficiency of one field with that of another, although it may be possible to do so after the mechanics of production have been analysed for many more reservoirs than have hitherto been studied in this respect.

H. B. M.

1055.* Permeability as a Function of the Size Parameters of Unconsolidated Sand. W. C. Krumbein and G. D. Monk. *Petrol. Tech.*, July 1942, **5** (4), A.I.M.M.E. Tech. Pub. No. 1492, 1–11.—Several attempts have been made to relate permeability to the particle size in unconsolidated sands, but few studies have included the effect of sorting on the permeability. The permeability depends on the square of the average grain diameter, the standard deviation of the size distribution, the mean shape, the standard deviation of the shape distribution, and a non-dimensional packing parameter. In the experiments described, the shape and packing factors were kept as constant as possible, while the size parameters were varied. A glacial outwash sand was sieved into $\sqrt[4]{2}$ classes from 0·125 to 8 mm., the twenty-four sets of separates being mixed to give normal phi curves. In the first set the phi standard deviation, σ_ϕ, was kept fixed at 0·21, while the phi mean varied from − 0·75 to 1·25. In the second set the phi mean was kept at zero and σ_ϕ was varied from 0·15 to 0·8. Permeability measurements were made on the different sands, and also on some of the separates, all measurements being made at a standard porosity of 40%.

On plotting permeability k against geometric mean diameter on log.–log. paper the sieve separates, and the mixtures which also had fixed standard phi deviations gave straight lines with the same slope, showing that the permeability varies as the square of the mean diameter. The mixtures of constant phi mean and constant geometric mean diameter showed a decrease in permeability as σ_ϕ increased. Plotting data for the last set of sands as log. permeability against σ_ϕ gave a straight line, pointing to an exponential relationship. This was shown to hold, and $k = C \cdot GM_\xi^2 e^{-a_1 \sigma_\phi}$, where C is the permeability at $\sigma_\phi = 0$, a_1 is a constant, and GM_ξ^2 the geometric mean diameter.

When σ_ϕ is constant, $k = C_1 \cdot GM_\xi^2$, C_1 being an exponential factor dependent on σ_ϕ.

The first relationship was tested on Wilsey's permeability data for a series of artificial

sands of variable mean size but of fixed spread, and gave good agreement with the experimental data.

A permeability surface was drawn relating permeability, geometric mean size, and σ_g for logarithmically normal size distributions of fixed porosity, although, as far as the experimental evidence goes at present, it has not been proved to apply to particles less than about 0·25 mm. G. D. H.

1056.* Phase Behaviour in the Methane–Propane–*n*-Pentane System. R. H. Dourson, B. H. Sage, and W. N. Lacey. *Petrol. Tech.*, July 1942, **5** (4), A.I.M.M.E. Tech. Pub. No. 1490, 1–10.—The compositions of the coexisting phases in the methane–propane–*n*-pentane system were determined at 160° and 220° F. throughout the two-phase region at pressures of 500, 1000, and 1500 lb./in.², and at 2000 lb./in.² at 160° F. The method involved the withdrawal of samples of coexisting gas and liquid phases from a vessel containing a heterogeneous mixture of methane, propane, and *n*-pentane. The samples were withdrawn under substantially isobaric, isothermal conditions after equilibrium had been attained, and their composition was determined by the conventional low-temperature fractionation procedure.

The experimental results permitted the calculation of gas–liquid equilibrium constants, as well as the establishment of the critical behaviour of this ternary system. The results are presented in tabular form, and diagrams show the molal composition at various temperatures and pressures, the effect of methane on the dew-point and bubble-point pressures, the pressure-composition diagram at 220° F., the temperature-composition diagram for 1500 lb./in.², the influence of pressure on the equilibrium constant for methane at 160° F., equilibrium constants for propane and *n*-pentane at 160° F., and the equilibrium constants of the methane–propane–*n*-pentane system when C equals 0·4 (C = the mol. fraction of propane in the liquid phase divided by the sum of the liquid phase mol. fractions of propane and *n*-pentane). G. D. H.

1057.* Determination of Oil-Well Capacities from Liquid-Level Data. C. C. Rodd. *Petrol. Tech.*, July 1942, **5** (4), A.I.M.M.E. Tech. Pub. No. 1475, 1–9.—Proration laws in Kansas took into consideration the quantity of oil which could be obtained from a well in a prescribed period, and various methods were used at times to obtain high potentials, potentials which could not be maintained and which were possibly conducive to early water encroachment. By 1938 the use of the bottom-hole pressure-gauge instead of the physical testing of wells had become common. Since 1937 devices have been developed which detect wave reflections from tube couplings and the well liquid level, and so permit the computation of the depth to the liquid level in the annulus around the tubing. These devices provide a ready means of measuring the liquid draw-down of a producing oil-well.

Potentials determined from bottom-hole pressures or liquid-level measurements are based on a straight-line relationship between the pressure at the bottom of the well and the rate of production. Such potentials give the productivity index—the number of barrels of oil/day/lb. reduction in bottom-hole pressure. In all but a few of the several thousand wells tested in Kansas the relationship between pressure and liquid production approximated a straight line. The factors needed for determining a well's capacity are the stable pressures at two producing rates, or the static pressure and a stable pressure at one rate. The former method is preferred.

By control of the casing pressure many wells can be produced without an appreciable quantity of liquid in the annulus. In such wells the effect of the liquid column becomes negligible, and bottom-hole pressures may be found from the casing pressure and the gas-column pressure. In some wells, the density of the annular liquid column remains constant at different rates of production. If these wells can be produced under zero casing pressure, the bottom-hole pressure can be considered as proportional to the height of the liquid column. The use of bottom-hole pressure gauges is troublesome. Many wells that produce little gas can be tested by the use of fill-up data.

The theory and calculations underlying the various methods of finding the productivity index are described. G. D. H.

1058.* Progress in Reservoir Technology. Part I. M. Muskat. *Petrol. Engr*, August 1942, **13** (12), 27–30.—The paper deals with the progress achieved in the last decade. Core analysis, thermodynamics of reservoirs, reserves estimation, and bottom-

hole pressure measurements constitute the four major portions of the first part. The treatment is, in general, descriptive and historical. Certain general rules are indicated in the case of bottom-hole pressure measurements. When the rate of pressure decline is combined with the production data in the manner used in the dynamical method of reserves estimation, it is possible to estimate the degree to which the oil withdrawals are replaced by the evolution of the dissolved gases, the expansion of gas in free gas zones, or by the intrusion of surrounding bottom-water or edge-water. The absolute value of the pressure decline below the virgin pressure also represents a measure of the depletion of energy in the reservoir, and hence of the depletion of recoverable oil. The pressure variations over a field, as indicated most conveniently by isobaric contours, give a graphic picture of the differential behaviour over the productive area of the field. Widely spaced contours and low-pressure gradients indicate a uniform degree of depletion or a high degree of fluid inter-communication between the various parts of the field either through the medium of an overlying gas-cap or the pay itself. Closely spaced pressure contours and high-pressure gradients reflect large variations in the extent of local depletion, or indicate poor fluid inter-communication, and the presence of inter-lease migration tendencies. Erratic and irregular contours will result either from a haphazard fluid withdrawal pattern over the field, or a marked lenticularity in the producing section. On the other hand, systematic trends of increasing pressures towards the boundaries of a field are indicative of the presence of undepleted energy sources at these boundaries, either in the form of additional oil reserves or mobile edge-water drives. Conversely, systematic trends of decreasing pressures towards the field boundaries correspond to the pinching out of the producing section, or to a failure of surrounding edge-waters to exert an effective drive on the reservoir. A. H. N.

1059.* Repairing and Redrilling Oil Wells. J. R. Thomas. *Petrol. Engr*, August 1942, **13** (12), 46.—The writer contends that repair work at all times offers a very lucrative return for small investment/unit. Over a period of 20 years, during which time the writer has been directly connected with the repairing of hundreds of wells, the average cost of production has been found to be approximately $120.00/brl. of daily production, which is less than half the cost basis on which the poorest grade producing property can be bought in the open market. The larger part of this work was done before well surveys, electrical logs, and other modern devices were available to assist the engineer. With these modern aids repair work should be even more attractive from the standpoint of sound economics.

Examples are given to illustrate the value of repair work on old wells.

A. H. N.

1060.* Use of Explosive Cord for Cleaning Perforations. W. A. Sawdon. *Petrol. Engr*, August 1942, **13** (12), 42.—The explosive applied to well-cleaning operations is provided in the form of a cord and is run into the well on a conductor cable. The cord extends through the zone to be cleaned and is detonated from the surface by electrical current. Best results are obtained when the explosive is in fluid, as the fluid facilitates the transmission of pressure that cleans the openings. The kind of fluid or the static head does not matter. The cord has been used in wells having temperatures as high as 275° F.

Although the explosive cord has the appearance of a slow-burning fuse, it explodes at a high rate of speed, the speed of detonation being more than 4 miles/sec. The amount of explosive/linear foot of cord, however, is very small, and is not sufficient to damage casing or liner. The cord is relatively safe to handle, as it requires considerable shock to begin detonation. The cleaning action of the explosive method of well-cleaning depends on the pressure induced by the explosion. As the full pressure must be applied to make it effective, the cleaning value is derived from the speed of detonation, because any open perforation to which pressure is applied in the usual manner will permit fluid to flow through it and relieve the pressure on the clogged perforations. Due to the great speed of detonation, fluid cannot pass through an open perforation fast enough to relieve the pressure on the clogged or partly clogged perforations, and the pressure is thus applied to all parts of the liner opposite the cord, to all perforations, whether open, partly closed, or closed.

Details of the method and results of experiments conducted above ground are given in brief. A. H. N.

1061.* Development, Operation, and Valuation of Oil and Gas Properties. Part 13. P. J. Jones. *Oil Gas J.*, 20.8.42, **41** (15), 43–44.—This is the concluding part of the series, and deals with estimation of oil reserves from production–decline rates. Formulæ are given with illustrative problems worked out in full. Graphs are included. Pay-out of investment is briefly discussed. A. H. N.

1062.* Safeguarding Oil and Gas Wells against Bombing and Sabotage. J. O. Farmer. *Oil Gas J.*, 20.8.42, **41** (15), 49.—Neither policing nor sand-bagging offers unfailing protection for well connections. The best protection lies in the use of safety mechanisms of a positive or automatic nature, placed several hundred feet below the surface, where they cannot be damaged by bomb impact or rendered ineffective by sabotage.

Full protection of a well against uncontrolled flow requires safeguarding of both the casing annulus and the tubing bore. If the casing annulus is not used as a flow conductor, it can be sealed off positively by setting a packer near the bottom of the well. When this is done on Gulf Coast marine locations, additional protection is gained by leaving the annulus full of heavy mud above the seal. The weight of the tubing, plus the weight of the mud column, holds the packer against the upward thrust of the formation pressure, and leaves the casing annulus dead at all times, thus assuring complete protection. Special packers for protecting the annulus in certain other circumstances are discussed.

The protection of the tubing section of the flow system is discussed historically from the development of the " storm chokes " in marine wells up to the present-day pressure-differential valves. The new valve is an over-sized bottom-hole choke into which is built a spring-loaded valve designed to remain open so long as the capacity of the bottom-hole choke is greater than that of the surface choke. As long as this relationship exists, virtually all the pressure drop is carried across the surface choke, since it is the point of greatest flow restriction. The instant the capacity of the surface choke approaches or exceeds that of the bottom-hole choke, the point of pressure reduction is transferred from the surface choke down to the bottom-hole choke, where the resultant pressure differential instantly snaps the spring-loaded valve closed.

The valve assembly consists of an orifice section, a spring-loaded main valve, and an equalising or by-pass valve. The main valve is above the orifice section, and is held open by the compression of a coiled expanding spring placed between the orifice section and the adjusting nuts on the lower end of the valve stem. Chevron-type packing prohibits flow between the valve stem and the orifice section; consequently all the flow from the tubing is directed through the opening in the orifice section. Any pressure drop across the orifice section acts against the area of the valve stem, tending to close the main valve against the action of the coiled spring. As long as the capacity of the surface choke is materially less than the capacity of the combined areas through the orifice section, practically all the pressure drop takes place at the surface choke—there being only a negligible drop across the valve stem. However, when the capacity of the surface choke approaches that of the openings, through the safety-valve orifice section, a pressure differential is set up across the valve stem, causing it to close instantly and to shut off all flow through the tubing. Heading, or surging, does not close the valve. The valve is shown in section. A. H. N.

1063. Applying Bottom-Hole Pressure Data to Production Problems. Part I. E. N. Kemler. *Oil Wkly*, 31.8.42, **106** (13), 22.—Proration by restrictions on maximum gas–oil ratio is discussed. Flow in a reservoir is the main subject of the first part of the paper. It is likened to flow in pipes. If the flow is viscous—that is, a viscous fluid such as a heavy oil and a small pipe size is used—the quantity which will flow will be proportional to the difference between P_1 and P_2, or

$$Q = C_1(P_1 - P_2).$$

The proportionality factor C_1 will depend on the viscosity of fluid, length of pipe, and size of pipe. If $P_2 = P_1$, then no flow will take place; and if P_2 is atmospheric pressure, the maximum flow rate will occur. In the case of an oil reservoir, three pressures may be known or desired as indicated in a drawing in the paper. P_m is the static reservoir pressure, or the maximum pressure available for forcing the fluid from the reservoir. P_1 is the pressure in bottom of the well, and is called the producing

bottom-hole pressure, and P_s is the top-hole producing pressure. As in the case of the pipe, the quantity of fluid produced by a well will be proportional to the pressure difference forcing the fluid through the sand or to $P_m - P_s$, or

$$Q = C(P_m - P_s).$$

This proportionality factor C will obviously depend on the type and thickness of sand or formation through which the fluid must flow. It is called the productivity index factor. It is generally equal to the brl./day which will be produced if the pressure at the sand-face is 1 lb./in.^{2} below the static reservoir pressure, or will be equal to the production increase in brl./day for each lb./in.^{2} decrease in bottom-hole producing pressure. In that case, P_m and P_s are given as lb./in.^{2} and Q is brl./day. In the case of the pipe the relation given in the first formula holds only so long as the flow is viscous. The same condition applied to the second formula for flow through a sand. Fortunately the flow conditions except at very high rates are such that the relation given in the second equation apply. Little data are available to indicate what would occur at very high rates, although pipe-flow data would indicate a much smaller increase in production with increased pressure differentials in these cases. Application of bottom-hole pressures in using these formulæ is indicated.

A. H. N.

1064.* Pumping Experiment Designed to Check Various Factors. G. M. Stearns. *Oil Gas J.*, 3.9.42, **41** (17), 31.—This is an advance report on experimental research being carried out on a pumping equipment at the University of Oklahoma. In planning the equipment set-up, the following requirements were kept in mind: (1) The conditions of an actual producing oil-well must be reproduced as nearly as possible. (2) The equipment must be so arranged that all pertinent phenomena can be observed and mathematical data accurately recorded. For this reason, it was decided to place all the equipment above the surface of the ground. (3) The equipment arrangement should be as flexible as possible, in order to allow changing from one test run to another without excessive delay. (4) The hook-up must be mechanically sound and safe for those who work on the project. A diagram illustrates the set-up.

Tests are being made first to determine the effect of variations in certain factors on the volumetric efficiency of one type of pump assembly when pumping oil of the specifications given in the paper. This is accomplished by holding all controllable variables constant except one for each test. Variation of the one variable and subsequent plotting of the pump efficiency for various values of that one factor will indicate the effect of that one isolated condition. In a like manner, each controllable factor can be isolated one at a time.

The variables investigated in this manner include: (1) Pumping speed. (2) Well depth. (3) Valve spacing. (4) Pump submergence. (5) Oil temperature. (6) Size and length of gas anchor. Similarly, different pump assemblies with the same oil will be tested to determine the effect of each variable. No results are yet given, but it is hoped to publish some within the year.

A. H. N.

1065.* Applying Bottom-Hole Pressure Data to Production Problems. Part 2. E. N. Kemler. *Oil Wkly*, 7.9.42, **107** (1), 26.—The significance of bottom-hole pressure in studying pumping data and in carrying out pumping tests is detailed and illustrated by a typical test on a well. The calculation of well capacity by extrapolation of production *v.* bottom-hole pressures graphs to zero pressure is illustrated. Bottom-hole pressure data at various rates of production either obtained from use of bottom-hole pressure gauge or fluid-level measurements is helpful in determining the size of equipment which should be installed on a well. The rational method of determining the size of equipment for use in a well is to make preliminary tests with drilling-in equipment in case a well is drilled in with cable tools or with a temporary pumping unit. In this case a well does not need to be produced at full capacity, since bottom-hole pressure data combined with production data at any reasonable rate of, say, 10% of the well's capacity or more, will permit extrapolation to maximum conditions. While some extra expenses would be involved in such a procedure, the proper fitting of equipment to the well will justify such expense where variable well size may be expected. The investment of a few hundred dollars in testing may result in several thousand dollars savings in investment and capital charges, and may possibly influence

operating expense either through lower maintenance costs or less operating labour required. The acoustic method of measuring fluid levels for the purposes of ascertaining bottom-hole pressures is described in brief.

The use of bottom-hole pressure or fluid-level data as a means of determining the well's capacity to produce has been applied to the determination of so-called potentials. While large amounts of fluid can be produced from moderate depths with sucker-rod-type pumping equipment, the cost required to obtain this production is not generally desirable. The size of equipment required to obtain this production is out of line with that required for normal operation under prorated conditions for a considerable portion of the life of the field. Fluid-level or bottom-hole-pressure data have been used to obtain the index of a well's capacity to produce, and have resulted in considerable reductions in investment, operating costs, and operating labour. Inasmuch as tests commonly made previous to the introduction of the productivity indexes were actually a measure of the equipment's ability to produce, the introduction of some method such as the productivity method will give on the average just as satisfactory results even though they are not absolutely correct. For areas such as Western Kansas, where little or no gas is produced with the oil, this method will work with the limits of accuracy with which data can be obtained. A. H. N.

1066.* Reservoir Pressures at Rincon Stabilized by Gas Return. N. Williams. *Oil Gas J.*, 10.9.42, **41** (18), 39–40.—There are nine horizons of producers in the field, but only four are at present injected with gas. First recorded bottom-hole pressure in the *D*, or 3700-ft. sand, was 1590 lb. By the time the pressure-maintenance operations were started the pressure had dropped to 1520 lb. On May 1, after 1 year of operations and with 188,540,000 cu. ft. of gas having been returned to the sand, the pressure for some time had remained around 1536 lb. Bottom-hole pressure in the *G*, or 4000 ft. sand, had dropped from 1764 lb. (first recorded pressure) to 1665 lb. As of May 1, 401,812,000 cu. ft. of gas had been injected and pressure was 1675 lb., at which level it had been for some time.

When gas injection was started in the *I* (4165 ft.) sand, bottom-hole pressure was 1375 lb., having declined 75 lb. from the pressure first recorded. Up to May 1, more than 273,450,000 cu. ft. of gas had been injected, and the rate of pressure decline had been substantially slackened, but the period of operation had been so short that definite results had not been determined. A similar condition exists in the *K* (4250 ft.) sand, in which only 25,500,000 cu. ft. of gas had been injected up to May 1.

It is proposed that as pressures in these sands become stabilized and as additional gas becomes available through new development, the return of gas will be extended or shifted to other sands. By rotation of gas injection to the various sands as pressures in these sands decline, it is hoped that pressure drop in all sands can be kept at a minimum, thus prolonging the flowing life of the wells and increasing the ultimate recovery. A. H. N.

1067.* Applying Bottom-Hole Pressure Data to Production Problems. Part 3. E. N. Kemler. *Oil Wkly*, 14.9.42, **107** (2), 40.—Flowing wells are studied in this part of the paper. The principles involved and the mechanism of flow in wells are first discussed. Graphs are used to illustrate the use of bottom-hole pressures in predicting the life of a naturally-flowing well by working out a typical example. Bottom-hole-pressure tests on flowing wells can be used for determining well potentials. Potentials in the case of flowing wells are more indefinite than for pumping wells. In the latter case the potential as determined by bottom-hole-pressure tests may be a value which is in excess of equipment capacity. Physical difficulties such as excessive gas may prevent actually realizing the indicated maximum well capacity. In the case of flowing wells the potential may refer to the indicated ability of the well to produce—that is, the indicated brl./day which the well will make if produced with zero pressure on the formation. It is pointed out that the ability of a flowing well to produce depends on the pressure drop in the tubing, as well as on the static bottom-hole pressure and the effective permeability or productivity-index factor. Any predicted actual ability to produce will depend on this pressure drop in the tubing. Any reference to potential on flowing wells must therefore be accompanied by the definition of potential if the result is to have meaning.

Potentials on flowing wells may be taken either with bottom-hole-pressure gauges

or by one of the fluid-level-measuring devices. In cases where considerable gas is produced through the casing, difficulty may be encountered in obtaining an accurate fluid level. Back-pressure methods have, however, been developed for such purposes, and satisfactory tests may usually be obtained by either method. A. H. N.

1068.* Corroded Casing Threatens Arkansas Sour Gas Fields. E. Sterrett. *Oil Wkly*, 14.9.42, **107** (2), 32.—Unless present encouraging corrective attempts prove successful, processing and utilization of Arkansas' vast and strategically located stores of sour gas face a possible serious set-back through the discovery that many of the casing strings in the 115 producing wells of the Magnolia field, Columbia County, have been perforated from within by corrosive action and are permitting leaks to the water-string or into barren formations above the string setting. A Commission is studying corrective procedures. Lacking laboratory reproduction of down-the-hole conditions under surroundings which permit observation and evaluation of the factors resulting in the casing failure, two possible reasons have been advanced. The electrolytic theory finds support in the fact that currents of an order as high as 2½ amp. have been detected at some wells, even though these strings may have been insulated from the surface flow-string by dielectric gaskets. So far no method has been worked out whereby protective or cathodic currents could be introduced and controlled within the affected wells for the arresting of the destructive action.

The hydrogen–sulphide theory advanced by some observers requires the presence of water before the H_2S present in the gas, in the proportion of 1500 grains/100 cu. ft. of gas, can become an agent of metal destruction. Since the gas does contain a certain amount of water vapour, and conditions at some points within the annulus between tubing and casing string fall to a temperature far enough below bottom-hole values to cause condensation, it is entirely possible that this vapour, condensing on the cool casing rather than on the relatively warmer tubing, would tend to flow down the string, the concentration being aided by inclination of the string or by the line of contact between tubing and casing. The fact that the casing alone is attacked by the dilute sulphuric acid formed by dissolving the hydrogen-sulphide of the gas in the droplets of water would tend to support the inclined trough hypothesis, rather than the tubing-contact theory.

Detection methods by pressure measurements are discussed. Remedial measures are still diverse and experimental. These are briefly discussed. A. H. N.

1069. Joule–Thomson Coefficients for Two Natural Gases. B. H. Sage, D. F. Botkin, and W. N. Lacey. *Petrol. Tech.*, September 1942, **5** (5), A.I.M.M.E. Tech. Pub. No. 1504, 1–5.—The Joule–Thomson coefficients of two natural gases were determined at pressures up to 600 lb./in.² through the temperature range 70–310° F., by measuring the temperature change on the passage of gas through a porous thimble under a known pressure difference. Deviations from steady state flow may have given rise to uncertainties as large as 2% in the measured coefficients. From these data and information relating to the isobaric heat capacities of the components at infinite volume, the heat capacities of the gases were computed throughout the same ranges of pressure and temperature.

The methods of correlating the isothermal changes in the enthalpy of pure substances, which have been based on the law of corresponding states, have been expanded to apply to multi-component mixtures. Also the enthalpy of multi-component gaseous hydrocarbon systems has been estimated from the partial enthalpies of the components determined by the behaviour of binary hydrocarbon mixtures. Enthalpies predicted by different methods were compared with those calculated from the experiments, and are shown in tabular form. In general the agreement between the several values was within about 3 B.Th.U./lb., but the partial enthalpy approach seems to give better values of the enthalpy with respect to temperature at low pressures than were obtained by the more general approach. The comparisons show that at pressures below 600 lb./in.² the currently available methods of prediction may be employed with some confidence. G. D. H.

1070. Patents on Production. C. J. Gibson. U.S.P. 2,296,514, 22.9.42. Appl. 15.7.40. Brush for cleaning perforated casing or lining by means of wire bristles.

C. W. Sproull. U.S.P. 2,296,582, 22.9.42. Appl. 10.7.39. Pump-operating mechanism by means of hydraulic power for deep-well pumping.

M. De Groote and B. Keiser. U.S.P. 2,296,600, 22.9.42. Appl. 21.3.41. Process for breaking petroleum emulsions of the water-in-oil type by subjecting the emulsion to a demulsifier comprising a water-soluble esterification product of certain classes of compounds.

J. H. Puls. U.S.P. 2,296,821, 22.9.42. Appl. 8.4.41. Multi-stage well-pump for deep-well pumping.

A. Boynton. U.S.P. 2,296,833, 29.9.42. Appl. 31.1.39. Input air or gas-control valve for cased wells.

A. Boynton. U.S.P. 2,296,835, 29.9.42. Appl. 31.1.39. Differential-type pneumatic piston pump.

A. J. Zschokke. U.S.P. 2,296,971, 29.9.42. Appl. 14.2.41. Bullet retainer for gun perforators.

M. E. Chun. U.S.P. 2,296,981, 29.9.42. Appl. 24.9.40. Method and apparatus for determining the point of water entry into oil-wells.

R. W. Lohman. U.S.P. 2,297,006, 29.9.42. Appl. 7.3.41. Gun-perforator firing system using electrical means.

G. F. Turechek. U.S.P. 2,297,037, 29.9.42. Appl. 14.2.41. Gun-perforator cartridge with easily removable case.

G. F. Turechek. U.S.P. 2,297,038, 29.9.42. Appl. 25.2.41. Gun perforator with a plurality of gun units.

W. G. Wellington. U.S.P. 2,297,041, 29.9.42. Appl. 19.2.41. Gun perforator.

E. L. Barker and C. P. Gillespie. U.S.P. 2,297,044, 29.9.42. Appl. 14.3.39. Bottom-hole choke for wells.

R. H. McKee. U.S.P. 2,297,062, 29.9.42. Appl. 23.5.38. Separation of oil from gas on production from a field.

J. P. Walker. U.S.P. 2,297,297, 29.9.42. Appl. 27.5.40. Treatment of oil, gas, and water mixtures in a continuous-closed system of treating oil emulsions.

L. A. Layne. U.S.P. 2,297,308, 29.9.42. Appl. 7.9.40. Well-bottom assembly for gravelling. A. H. N.

Transport and Storage.

1071.* Corrosion of Pipe-Lines. A. H. Stuart. *Petroleum*, February 1942, **5** (2), 33.—One of the major corrosion problems in industry refers to buried pipe-lines, and in these the development of pits is more important than general corrosion. The most important factor in this respect is the nature of the soil, and it has been shown that pit depth varies roughly as the acidity of a soil and inversely as its resistance to an electric current.

Coating of the pipe is the most obvious form of protection, but while suitable coatings are readily available, the development of a satisfactory technique for applying them is difficult. The surface of the pipe must be thoroughly cleaned and dried before the coating is applied. The coating of moist pipes leads to the development of rust under the protective layer, with subsequent deterioration of the coating. To overcome this trouble pickling has been tried with some success.

Other methods consist of spraying the surfaces with aqueous solutions which precipitate an anti-corrosive chemical film on the iron. Combinations suggested are zinc sulphate or lead nitrate sprayed simultaneously with potassium dichromate or disodium phosphate. The films deposited afford a bond for the paint or other protective material afterwards applied. D. L. S.

1072.* Protecting Buried Metals Against Corrosion. Starr Thayer. *Oil Gas J.*, 2.4.42, **40** (47), 37.—A short, general account of the methods used for combating pipe-line corrosion losses, which may amount to upwards of 100,000,000 dollars annually.

In laying new pipe-lines extra expense which may be incurred in avoiding known corrosive areas—*e.g.*, swamps—is not considered justifiable, but protective coatings are usually applied.

Older lines can be given cathodic protection, based on correcting the potential differences which may exist between small sections of the pipe-wall or may be due to changes in soil conditions.

The various methods in use for making the pipe-line cathodic to the surrounding soil are described, and examples are given of the practical effects of the process.

J. C.

Cracking.

1073.* Compositions of Catalytically Cracked Gasolines. J. R. Bates, F. W. Rose, S. S. Kurtz, and I. W. Mills. *Industr. Engng Chem.*, 1942, **34**, 147.—The composition of catalytically cracked gasolines has been investigated by analysis for olefins and aromatics by well-established methods, followed by a fractional distillation examination of the residual paraffins resulting from controlled acid washing. This examination shows that the ratio of *iso* to normal paraffins present in catalytically cracked gasolines is considerably higher than that existent in thermally cracked gasolines. This high concentration of *iso*paraffins in the lower boiling range, together with the high aromatic content in the higher boiling range, is responsible for the octane number of catalytically cracked gasoline.

Comparative data for the ratio of *iso* to normal paraffins for C_4, C_5, C_6, and C_7 hydrocarbons are given for cracked gasolines from various sources. J. W. H.

1074. Patent on Cracking. J. V. Marancik and H. Z. Martin. U.S.P. 2,296,722, 22.9.42. Appl. 26.8.39. Method of catalytically cracking hydrocarbon oils to form lower-boiling motor-fuel products. A cracking catalyst substantially free from carbonaceous deposit is suspended in a stream of the oil to be cracked and the resultant suspension is passed through a cracking zone. Afterwards the catalyst is separated from the cracked products and suspended in a stream of oil, which is more amenable to cracking than the first stream. This suspension is passed through a separate cracking zone, and the products are fractionated to produce a motor-fuel fraction.

H. B. M.

Hydrogenation.

1075. Catalytic Poisoning in Liquid-Phase Hydrogenation. A. G. Deem and J. E. Kaveckis. *Industr. Engng Chem.*, 1941, **33**, 1373.—Sulphur compounds in five different states of oxidation were investigated to determine their effect on the rate of hydrogenation of phenol, naphthalene, and quinolene employing a Raney nickel catalyst. Only those compounds in the lower state of oxidation poisoned the reaction to a high degree. J. W. H.

Polymerization and Alkylation.

1076.* Low Temperature Catalytic Alkylation of *iso*Paraffins. P. D. Caesar and A. W. Francis. *Industr. Engng Chem.*, 1941, **33**, 1426.—A reaction mechanism is proposed which accounts for substantially all the observed paraffin isomers resulting from the low-temperature alkylation of *iso*paraffins. J. W. H.

Synthetic Products.

1077.* Present Status of Synthetic Rubber. E. R. Bridgwater. *Industr. Engng Chem.*, 1941, **33**, 1342.—The various types of synthetic rubber are reviewed, their uses discussed, and the quantities produced during the years 1939–41 are given. The article summarizes the production of synthetic rubber in a general manner.

J. W. H.

1078.* **Butadiene is Real Bottleneck in Synthetic Rubber Programme.** J. P. O'Donnell. *Oil Gas J.*, 26.3.42, **40** (46), 128.—The requirements of the U.S.A. synthetic rubber programme will be minbr compared to the demands for high-octane gasoline, since 500,000 tons annually will require 3,750,000 brl. of butadiene, whilst 100 octane fuel has a projected goal of 91,250,000 brl. annually. In spite of the fact that neither has the raw material resources of the U.S.A., Germany is estimated to be producing 100,000 tons of synthetic rubber annually and Russia 50,000 tons. Germany uses butadiene, made not from petroleum, but from coke and lime via acetylene, acetaldehyde, aldol, and butylene glycol. Russia's process is less involved, starting with ethyl alcohol, by the fermentation of grain and potatoes, followed by catalytic conversion (passing the vapours over Al–Zn oxide at 400° C.) into butadiene.

W. Nelson has estimated that 129,000 brl. of butane are available daily in the U.S.A. From butane, butadiene may be obtained by dehydrogenation via butylene. Catalysts of the Cr, Mo, Va oxide-on-alumina type are employed at low pressures and at 600–650° F. in a typical process. By the use of recycling, yields as high as 79% from butene and 65% from butane have been reported.

A list of the principal synthetic rubbers, manufacturers, raw materials, and compositions is given, but only the following five are in relatively large-scale production: (1) polymerized butadiene, (2) Buna S, (3) Buna N or Perbunan, (4) polysulphides (Thiokol), (5) neoprene. Russia alone makes (1) in quantity, Germany having abandoned it for the more versatile copolymers (2) and (3).

Buna S is produced by the copolymerization of butadiene and styrene, emulsified in water with soap or other emulsifier. Catalysts and modifying agents may be added (types are quoted), and the mixture is maintained at 50° C. for about 12 hrs. An inhibitor or stabilizer—*e.g.*, phenyl-β-naphthylamine—is added to prevent further polymerization, and the resultant latex, coagulated with acetic acid, washed and dried, is similar to natural latex. Buna S is the type which Government plants will produce, and compounded with carbon-black is reported to be superior to natural rubber in heat and abrasion resistance. It is the least expensive of the major synthetics available for tyres, and because of its importance, a detailed table of its properties compared with those of natural rubber is given.

Buna N (Perbunan) is the result of copolymerizing butadiene and acrylonitrile, and is superior to natural rubber in oil and solvent resistance. Buna S and N may be varied in properties by varying the ratio of the copolymers, the polymerization environment, and the conditions of vulcanization.

Neoprenes, made by the polymerization of chloroprene (chlorbutadiene) by emulsification in water, are superior to natural rubber in resistance to sunlight, heat, and oils, and are less inflammable.

A table is given of the reactions involved in the above processes.

Polysulphide rubbers produced by condensation of organic dihalides with sodium tetrasulphide are outstanding in oil, solvent, and oxidation resistance, and are made in Japan as well as in the U.S.A. Various other synthetic rubbers are briefly described.

In 1941 neoprenes constituted about 52% and butadiene types 35% of the U.S.A. total production of 12,000 tons. The present plans to raise the production to 400,000 tons annually are discussed, and companies participating, new plants, and others under construction are referred to. The 1942 production should reach the impressive but inadequate total of 95,000 tons, and the rate of 400,000 tons annually will not be reached until late 1943 or 1944.

The dominant rôle is to be played by butadiene types, and the liquid butadiene will be shipped under pressure to the processing plants. The styrene for Buna S may be made by dehydrogenation of ethyl benzene, or may be separated from cracked gases or recovered during the manufacture of carburetted water gas. Acrylonitrile may be obtained by dehydrogenation of ethylene cyanohydrin or by catalytic addition of HCN to acetylene.

A short account of the history of synthetic rubber processes is given, including Germany's processes during the World War and later. It is interesting to note that Thiokol was first obtained during a search for an anti-freeze.

A discussion of the comparative costs of natural and synthetic rubber, at present expensive, indicates that there are differing opinions as to whether the synthetic materials will eventually be cheaper than the natural, but their peculiar properties will in any case ensure them a market. J. C.

1079.* Thermodynamics in Isomerization. P. Buthod and W. L. Nelson. *Oil Gas J.*, 26.3.42, **40** (46), 120.—The isomerization process is important, since it converts low-octane-number normal paraffins into high-octane-number *iso*paraffins—*e.g.*, normal heptane of octane number 0 into 2 : 2 : 3-trimethylbutane of octane number 101.

Almost any chemical reaction is theoretically possible, but practical factors are the extent to which it will proceed and the rate at which it occurs. Thermodynamics is of little help as regards the second factor, but the first can be studied by computation, involving the free energy concept. The method for calculating the compositions of the equilibrium mixtures, resulting from the isomerization of the lower-range gasoline hydrocarbons, is outlined, and is dependent on an equation, relating the standard-free energy change of the reaction with the absolute temperature, the gas constant, and the mass-law equilibrium constant. Results, shown graphically, have been worked out for the isomerization of butane, pentane, hexane, heptane, and octane hydrocarbons, and show that the desirable branch-chain products of high octane number predominate if the process can be carried out at low temperature. Thus, when a mixture of 8 carbon-atom (octane) molecules is isomerized at 1000° F., the product has an octane number of about 14, but if the reaction is carried out at 100° F., the octane number of the product will be 96, irrespective of the feed-stock octane number.

The results of thermodynamic computation must be interpreted with caution, and the figures quoted are applicable only to isomerization reactions, and not to decompositions, alkylations, etc. Side reactions, of which carbon formation is a troublesome example, complicate the situation. Moreover, many of the isomerization reactions will be very slow at the desirable low temperatures, and commercial application will be dependent on the discovery of suitable catalysts. In spite of its disadvantages, the thermodynamic method is the only general method available by which probable reactions can be selected from the vast number of possible reactions, and a thorough mathematical study to determine free energies from existing physical data, and from these the most probable reactions for each boiling range of petroleum, might form the basis of a petroleum chemical industry. J. C.

Refining and Refinery Plant.

1080.* Agitation. A. W. Hixson and S. J. Baum. *Industr. Engng Chem.*, 1942, **34**, 120.—The performance of propellers in liquid–solid systems is correlated in the form of a dimensionless equation. Data for four geometrically similar systems are correlated by this method, from which it is concluded that model experiments can be made in the prediction of agitator performance. J. W. H.

1081.* Electrical Stability of Mineral-Oil-Treated Dielectrics. F. M. Clark and E. L. Raab. *Industr. Engng Chem.*, 1942, **34**, 110.—An investigation is made on the acid refining of distillate oils to the greatest impregnating dielectric stability. For the type of distillate studied it is shown that the object of the refining is to remove the olefin type of hydrocarbons without appreciable removal of the aromatics. The greatest electrical stability was obtained with a 22% aromatic unsaturation content, which was obtained by the use of approximately 4·5 lb. of 96% acid per gallon of oil at a treatment temperature of 20° C. J. W. H.

1082.* Catalytic Desulphurization by Use of the Gray Process. A. M. Martin and L. Carlson. *Oil Gas J.*, 26.3.42, **40** (46), 138.—Sulphur in gasoline was formerly objected to because of its possible corrosiveness and its odour, but now its most important effect is depression of lead susceptibility.

Sulphuric acid refining improves lead susceptibility to a limited extent, but large volumes of acid are required, high losses are entailed by solution and polymerization of the gasoline, whilst there are the problems of acid recovery and sludge disposal. Doctor sweetening converts mercaptans into less odoriferous compounds, which, however, still depress the lead response, whilst other methods in large-scale use remove mercaptans but not other sulphur compounds.

In the Gray catalytic process both mercaptan and non-mercaptan sulphur com-

pounds are largely eliminated by passing the gasoline vapours through a bed of solid adsorbent catalyst, such as fuller's earth, at elevated temperature. A flow diagram pertaining to an actual commercial installation is shown. A large part of the sulphur present is converted into H_2S, and the removal of the H_2S is the only other treatment necessary for the gasoline.

Tables are given of the different effects of a wide selection of clays on straight-run gasolines, and in a discussion of the applications of the process it is claimed that the octane number is improved, as well as the lead response. The total sulphur reduction may range from 60 to 85%, but the process for any stock is best assessed by the lead tetraethyl saving; it may be applied to certain aviation base stocks as well as to motor fuel.

Operating costs are low, the unit being of simple design with a measure of automatic control. J. C.

1083.* **Three-Way Refinery Developed for War Production.** O. W. Wilcox. *World Petroleum*, April 1942, **13** (4), 26.—The American refining industry faces an enormous task in meeting the ever mounting requirements for 100 O.N. aviation gasoline. To enable the small refiners to play their part, the O.P.C. (Office of the Petroleum Co-ordinator) has evolved a standard plan for proposed combination units to produce aviation gasoline, toluene for explosives, and butadiene for synthetic rubber. Where a single refiner's operations are not large enough to justify the erection of the optimum capacity 3-way plant, it is suggested that several smaller refiners combine to construct and operate such a plant.

The standard design allows various alternatives to fit special conditions, and aims at flexibility, but in general conforms to a scheme shown in a simplified flow sheet, and begins with crude, specially selected for its content of high-octane material, entering a topping still. Topping plants will not necessarily be installed at the combination 3-way units, and existent topping stills will if possible be used. In such cases the refiners will pool their reduced crudes, naphthas, and alkylation materials and deliver them to the combination plants.

The heavy naphtha will go to a reforming unit, which may be of conventional thermal type or of modern catalytic design—*e.g.*, the Houdry or the U.O.P. The reduced crude goes to a catalytic cracking unit, which may be of the Houdry type or may employ a fluid catalyst (details not allowed to be made public), but in any case the products are gas, gasoline, and gas oil or domestic fuel oil. This gas, together with gas from the reforming unit, will go to the gas-recovery unit, to be stripped of all products of military value, which include propylene (for chemicals or for *iso*propyl alcohol to be used as a blending agent, or to be mixed with *iso*butane for the alkylation unit) and ethylene (for styrene production for artificial rubber). The flow diagram shows a styrene unit, which involves the complication of a benzene supply for combination with the ethylene. The benzene may be obtained from outside, or may be produced by close fractionation of the aromatics in the toluene cut.

Accurate control of temperatures and pressures will be necessary in the gas-recovery unit for maximum yields of butanes and butenes. Details of debutanizing equipment are not given, but the C_4 cut is shown as being split into two fractions, one containing *n*-butane and butene-2, and the other *iso*butane, *iso*butene, butene-1, and possibly butene-2. The first fraction will be dehydrogenated to produce 99·5% pure butadiene. The second fraction goes to an alkylation plant to produce alkylate for 100 O.N. fuel and residue, "heavy alkylate," for motor fuel. Various alkylation processes may be used, but most employ sulphuric acid as catalyst. Butadiene production may be increased by obtaining outside supplies of butane from natural gasoline plants or by preparing alcohol from ethylene and converting catalytically to butadiene. On the other hand, the production of alkylate may be increased by taking all the available butene-2 to the alkylation unit or by bringing in outside *iso*butane to alkylate propylene.

The gasoline from the catalytic cracking plant is fractionated to produce a "heart cut" rich in toluene, which goes to the toluene extraction unit, which also receives reformed gasoline (dependent upon its toluene content). Toluene extraction may be effected by azeotropic distillation, by distillation with methanol, or by extraction with sulphur dioxide or phenol. The raffinate, plus the remainder of the catalytically cracked gasoline, is catalytically treated to reduce gum and improve stability, and then

fractionated, one cut becoming aviation blending stock and the other high-O.N. motor fuel.

The gas oil from the catalytic cracking unit, if not otherwise required, may be thermally cracked for motor fuel and for additional gas supplies. J. C.

1084. Increasing Production with Clean Condensers. C. L. Weldell and W. B. Borst *Refiner*, August 1942, **21** (8), 243–245.—The problems involved and their solutions in increasing the capacity of a 6500-brl. plant to 8500, by attention to the condensers and heat exchanges, are discussed. The plant is confined to gasoline, kerosene, and fuel oil, and utilizes two crude units and one Dubbs unit. A. H. N.

1085. Laboratory Control Reduces Refinery Corrosion. A. W. Trusty. *Refiner*, August 1942, **21** (8), 250–252.—Some brines contain mostly sodium chloride and give less corrosion than other brines containing magnesium salts. The chemist should analyse the briny water from each crude oil processed at his plant to determine the relative proportions of sodium, calcium, and magnesium ions. Where calcium and magnesium are present, the total salt content of the crude oil should be reduced to a lower figure than in the case of a brine containing only sodium chloride.

Salt is most commonly encountered in crude oil in the form of brine-drops. It is only the very small brine-droplets which are difficult to remove from the oil. Larger drops, exceeding 0·01 mm. in diameter, settle readily, and are removed from the crude oil in the field. The presence of wax contributes to the difficulty of salt removal. Both brine-drops and solid salt crystals are stabilized by a thin coating of wax in the crude. A temperature of 120° F. will dissolve the wax in East Texas crude, while a temperature of 160° F. is required to dissolve the wax in Rodessa crude oil. The salt content of an oil is usually determined by diluting the oil with an organic solvent to decrease the viscosity and to minimize emulsion formation, followed by thoroughly agitating the oil with warm water, settling, and analysing the water extract. The water extraction is quite satisfactory in cases where the salt occurs in the form of brine solutions. If the salt is present in the form of crystals, however, it has been found that prolonged shaking does not completely dissolve the solid salt.

Centrifuging, likewise, will remove crystalline salt with difficulty. Ten minutes of centrifuging removed all the water, but 2 hrs. of centrifuging failed to remove all the salt from a sample of Rodessa crude containing crystalline salt. Details of tests for determining the salt content and the chemical compositions of the salt are given. Determination of p_H and the effects of sulphur in cracking plant corrosion are discussed. A. H. N.

1086. Metallizing to Prolong Life of Equipment. J. E. Young, Sr. *Refiner*, August 1942, **21** (8), 246–248.—If one or two points are always remembered when making use of this process, there will be little difficulty in obtaining good results. First, the deposited metal is not welded to the base metal. The bond is purely mechanical, and for this reason the preparation must be thoroughly and carefully done. Second, regardless of the kind of wire used, the metal is "cast," and should therefore be machined and handled like a casting. This cast metal provides an excellent wearing surface, usually wearing several times longer than rolled metal of the same specification.

The most frequent refinery applications are: resurfacing pump-rods and shafts, building up bearing and packing areas on steam turbines, pistons and piston rods on gas engines and air compressors, seal rings in centrifugal pumps, filling in cavitated areas of centrifugal water-pumps, and many others that will occur in normal shop operation. The worn part is usually set on a lathe, a thread is cut with very rough sides, and the metal is melted and sprayed on the worn part to deposit in the thread and interlock in the rough interstices. Care has to be taken that no grease, moisture, etc., is deposited on the threaded worn part before application of the sprayed metal. Details are given regarding precautions, and methods to be adopted. A. H. N.

1087. Multi-Component Distillation. C. D. Shiah. *Refiner*, August 1942, **21** (8), 240–242.—This paper presents a new graphical method for the stepwise calculation of multi-component distillation problems, which, with the aid of Shiah's K-chart, uses a single curve to represent the equilibrium curve for all the components. Use

is also made of both Hibshman and Robinson and Gilliland's technique to obtain the concentration of each component, as well as the temperature on any plate with practically no trial-and-error work. The paper is supplemented with a large chart, the derivation and use of which are explained and further illustrated by an example worked out in full. A. H. N.

1088. Proper Electrodes for Refinery Welding. W. L. Archea. *Refiner*, August 1942, **21** (8), 253–256.—In order to establish standards for welding electrodes, the American Welding Society and the American Society for Testing Materials collaborated in issuing a specification for welding electrodes. Thus the user of welding is enabled to talk about welding rods in terms of their current characteristics and physical properties by merely stating the grade. A table gives a summary of the American Welding Society classification number as a guide to welding positions, description of electrode and current requirements, heat treatment, and primary physical properties of all-weld metal tension specimens. The table deals with four electrodes, but the paper discusses only three grades. A. H. N.

1089. Petroleum-Refining Methods Available for War-Time Demands. J. F. Thornton and W. C. Dickerman. *Petrol. Tech.*, September 1942, **5** (5), A.I.M.M.E. Tech. Pub. No. 1503, 1–7.—The spreading of war is making exceptional demands on the oil industry. Large quantities of 100-octane gasoline, extreme service lubricants, toluene, and miscellaneous products are needed. The 100-octane gasoline is blended from *iso*pentane, base stock, and alkylate. *iso*Pentane is fractionated from natural or refinery gasoline. It has not yet been necessary to resort to the isomerization of normal pentane. Catalytic cracking is rapidly becoming the major source of the base stock, which should have a good octane rating and high lead response. Alkylate, the most important component, is synthesized from *iso*butane and olefin.

Fortunately the United States finds itself with well-developed processes already available for the production of the highest-quality lubricants. Toluene is now being produced by new methods from special cuts fractionated from selected crudes, or from catalytically processed naphthas.

Designers of refinery equipment are modifying past practices in order to conserve materials as far as possible. G. D. H.

1090. Patents on Refining and Refinery Plant. Standard Oil Development Co. E.P. 547,942, 18.9.42. Appl. 19.6.40. Separation of olefins from gaseous mixtures containing them by contacting the mixtures with a saturated absorbent solution of cuprous salt in a solvent taken from the class consisting of ethers and alkyl and aryl nitriles, and alkyl and aryl phosphates.

W. W. Gary. U.S.P. 2,296,992, 29.9.42. Appl. 21.7.39. Method of separation of light hydrocarbons including methane and ethane from a crude petroleum oil and of recovering desired hydrocarbons from the separated light hydrocarbons and from a hydrocarbon gas mixture. H. B. M.

Chemistry and Physics of Hydrocarbons.

1091.* Latent Heats of Vaporization. H. P. Meissner. *Industr. Engng Chem.*, 1941, **33**, 1440.—An equation and a graphical solution to an equation are given which enables the molal latent heat of vaporization to be computed from the vapour pressure, if the critical temperature and pressure of a pure liquid are known. The calculated latent heats are compared with the experimentally determined values for some thirty compounds which shows that the equation is valid to an accuracy of $\pm 9\%$ for both polar and non-polar liquids with an average error of $\pm 5\%$. J. W. H.

1092.* Dielectric Properties of Hydrocarbons and Hydrocarbon Oils. J. C. Balsbaugh, A. G. Assay, and J. L. Ongley. *Industr. Engng Chem.*, 1942, **34**, 92.—A study is made of the influence of oxidation on the dielectric properties of several pure hydrocarbons and a series of hydrocarbon oils. It is shown that in the presence of copper, the salt of a 5-carbon dibasic acid is formed. If the oxidation is carried out under

restricted oxidation conditions a highly dissociated electrolyte is formed giving high conductivities or power factors. Measurements of the electrical properties of the oil itself are made, and similar measurements for the oil in combination with paper.
J. W. H.

1093.* Theory of Open-Tube Distillation. J. W. Westhaver. *Industr. Engng Chem.*, 1942, **34**, 126.—An equation expressing the H.E.T.P. in terms of V_a, the vapour velocity, r_0, the radius of the tube, and D, the molecular diffusion coefficient of the vapour stream is given as

$$\text{H.E.T.P.} = (11/48)\, V_a\, r_0^2/D + D/V_a.$$

This fixes the minimum value of the H.E.T.P. as $0{\cdot}96r_0$, and it occurs at a vapour velocity of $2{\cdot}1(D/r_0)$, which is considerably below the range of any experimental data. At ordinary vapour velocities it is shown that the theoretical H.E.T.P. and experimental data are in good agreement.
J. W. H.

1094.* P-V-T Relations and Derived Quantities for Hexanes. E. A. Kelso and W. A. Felsing. *Industr. Engng Chem.*, 1942, **34**, 161.—The molal volumes and pressure-volume-temperature relations for 2 : 3-dimethylbutane, 2-methylpentane, and *n*-hexane have been determined over the temperature range 100–275° C. From this data the values of Z in the gas equation $pv/RT = Z$ and the fugacity coefficients f/p have been calculated.
J. W. H.

1095.* Pressure-Temperature Chart for Vapours. M. Hirsch. *Industr. Engng Chem.*, 1942, **34**, 174.—A new method of plotting logarithmic pressures using convergent isotherms is given which enables an estimation of the vapour pressure to be made from a limited amount of data. The use of this method is illustrated in detail by examples and comparative data calculated by the method, and determined results show that the method offers considerable accuracy.
J. W. H.

1096. Specific Volumes and Phase-Boundary Properties of Separator-Gas and Liquid-Hydrocarbon Mixtures. K. Eilerts and R. V. Smith. U.S. Bur. Mines. Report of Investigations No. 3642, April 1942.—It is pointed out in the introduction to this report that a knowledge of the phase relations of fluids produced from "combination wells" at the pressures and temperatures characteristic of production from natural reservoirs is essential to efficient recovery and refining practice. In this connection "combination wells" are taken to mean those wells where gas and light volatile hydrocarbon liquid in quantities of economic significance are recovered at a relatively high ratio of gas to liquid. For purposes of laboratory investigations described, accurate samples of the fluid from such a well were prepared by mixing (in the proportions of the measured gas : liquid ratio) gas and liquid taken from the separator under conditions of steady flow.

Specific volumes as a function of pressures up to 5000 lb./in.^{2} abs. and temperatures ranging from 70° to 280° F. were measured on ten mixtures of separator gas and liquid samples. Distillation analyses were made to determine the composition of the natural hydrocarbon mixtures, and further experimental data were collated to provide information for evaluating phase-boundary properties of the mixtures in terms of pressure, temperature, and composition.

Results obtained in regard to specific volumes of two-phase fluids at sub-atmospheric pressures were used in calculations of compressibility factors of mixtures containing 50% or more separator gas.

Bubble-point and dew-point phase boundaries of mixtures for the temperature range of 70–280° F. were determined from specific volume data. The locus of the maximum pressures (composition constant, temperature variable) at which given mixtures could be maintained in coexisting gas and liquid phases and the locus of maximum pressures (temperature constant, composition variable) for maintenance of the two-constituent system in coexisting gas and liquid phases were evaluated as a function of pressure, temperature, specific volume, and composition. The maximum pressure at which a mixture of the separator gas and liquid in any proportion could exist in two phases was 3940 lb./in.^{2} abs. At this pressure, common to both

leei of maximum pressure, the temperature was 149° F. and the composition 62·6 mass-per cent. separator gas. H. B. M.

1007.* Hydrocarbon Hydrates. I. C. Bechtold. *Petrol. Engnr*, April 1942, **13** (7), 57.—Increased pressure in transmission systems during the last 10 years has increased the frequency of formation of solid hydrocarbon hydrates, which has led to their study from a commercial point of view and to the accumulation of considerable fundamental data.

The chemical composition is not easily ascertained by analysis, since the hydrates are stable only under conditions of relatively high pressure and low temperature; in all ordinary circumstances they will exist in the presence of unknown amounts of excess vapours. For example, ethane hydrate has been reported as $C_2H_6.7H_2O$ and $C_2H_6.6H_2O$ by different investigators. Hydrates of methane, ethane, propane, and the butanes have been reported in the literature, but there appears to be doubt as to whether *n*-butane forms a hydrate. Villard has described hydrates as dissociable compounds, capable of existing only in the solid state, formed by water with various gases, isomorphous between themselves, crystallizing in the cubic system, and of composition represented by the general formula $M.6H_2O$.

The equilibrium conditions for the coexistence of solid hydrate, vapour phase, and water are represented graphically for the pure gases methane, ethane, and propane, but for actual natural gas they will be dependent on composition. It is considered that it is possible to determine the conditions conducive to hydrate formation in apparatus such as pipe-lines, pressure vessels, and plant equipment; a typical example is discussed.

The elimination of hydrates already formed may be effected by lowering the pressure, which is not always practicable, or by raising the temperature, which is often dangerous and not generally satisfactory, since it is rarely possible to heat the entire system and to prevent re-formation at some other point. Substances may be introduced which have a lowering effect on the decomposition temperature—*e.g.*, methyl, ethyl, or propyl alcohol in small amounts, or gaseous ammonia. In the latter case, if carbon dioxide is present there is danger of solid ammonium carbonate formation, which may cause more trouble than the hydrate plug.

Prevention of hydrate formation is more important, and may be effected by dehydrating the gas so that it will never be saturated with water vapour under any temperature and pressure conditions it may encounter in the system. Well-known methods include refrigeration, glycol absorption, action of solids such as activated alumina or silica gel, contacting the gas with calcium chloride or sodium chloride brine, and so on. Local conditions of temperature and the pressure in the installation will determine how much water must be removed. J. C.

1008. Hydrocarbon Chemistry for the Refinery Worker. P. H. Faust. *Refiner*, August 1942, **21** (8), 227–231.—An elementary review of the chemistry of the hydrocarbons is given. Thermodynamical principles are briefly sketched. The paper ends with a short description of chemistry in the refining and conversion of petroleum products. A. H. N.

1009. Gas Analysis with the Mass Spectrometer. J. A. Hipple. *J. Appl. Phys.*, September 1942, **13** (9), 551–560.—The fundamentals of gas analysis by mass spectrometry are discussed. The sample of gas to be analysed is admitted to a vacuum tube in the region of a small slit, by means of a capillary leak; the gas flows through the tube and out of the pumping lead by means of mercury or oil-diffusion pumps, the pressure being of the order of 10^{-4} mm. Hg or lower. An electron beam cuts across the gas stream and ionizes some of the molecules of the gas. The electron current is of the order of a few microamperes, and the electron accelerating voltage is usually variable between 0 and 100 volts. The beam of ions travels through a second slit, towards which it has been accelerated by a difference of potential of about 500 and 1000 volts existing between the two slits. The beam travels in a straight line until it meets a magnetic field at right angles to the main path of the beam, when it bends into a circular path, and by an appropriate adjustment of the ion accelerating voltage and the magnetic field strength, ions of a particular mass to charge ratio are

caused to follow the curve of the vacuum chamber, emerging from the magnetic field region after a deflection of 90° and entering a third slit. Upon leaving the third slit the ion beam is captured in a Faraday cage, and the current corresponding to this particular mass is measured. For example, if it is desired to analyse a sample containing a mixture of nitrogen (mass 28) and oxygen (mass 32), with the fields adjusted for mass 28 to pass through the tube, mass 32, being bent less by the magnetic field, will hit the ground inside the tube and be lost. Having measured the current corresponding to mass 28, the voltage between the first slit and the second slit is decreased until mass 32 passes through all the slits, and this current is then measured. These two readings are then a measure of the relative number of molecules of N_2 and O_2 in the original sample. In an instrument of general utility, the first, second, and third slits are of the order of half a millimeter, and the radius of curvature in the magnetic field 10–15 cm. The ion current passing through the tube may be 10^{-10} to 10^{-15} ampere.

References are given to papers dealing with particular molecules, such as He, Ne, etc., including hydrocarbons, which have been so analysed and studied.

In working with hydrocarbons especially, it is important to avoid thermally dissociating the molecule by the heat from the filament; to get a reproducible mass spectrum, all the dissociation must be due to electron impact. For this reason an oxide-coated filament is used in this work, although a tungsten filament could probably be used if sufficient precautions were taken. The design is such that the gas is admitted to the ionization region and then pumped out past the filament.

Rather complicated mixtures of hydrocarbons have been successfully analysed. The results of the analysis with the mass spectrometer checked exceedingly well with the known composition of the mixture. In this work, mixtures of as many as five components were analysed. In one case the mixture was methane, ethane, propane, *iso*butane, and *n*-butane; in another, the components were *iso*butene, (1-butene, 2-butene lumped together), *iso*butane, and *n*-butane. A. H. N.

1100.* The Cyclisation of Hydrocarbon Mixtures. S. J. Green. *Journ. Inst. Pet.*, September 1942, **28** (225), 179–207.—An exhaustive study of previous work on the subject, together with thermodynamical analysis of the possibilities of cyclization form the introductory part of the paper. Experimental apparatus and procedure are described in detail. The results of the work are given in full, together with incidental work on the desulphurization of the material by the catalysts. The chief conclusions are summarized as follows:—

Cr_2O_3 from chromic acid, on floridin as carrier, showed negligible activity, whereas when the sesquioxide was prepared from chromium nitrate, using the same carrier, the aromatics and unsaturateds in a hydrocarbon mixture were increased by 16%. Copper chromite and molybdenum sulphide on various carriers were active, but the introduction of activated alumina increased the activity of these and other catalysts considerably. Activated alumina alone was also active.

Various mixtures were passed over a molybdenum–alumina catalyst, and it was found that *n*-heptane is more easily aromatized than technical heptene. The reactions of other mixtures are discussed, and *o*-xylene was identified from the aromatization of 2 : 2 : 4-trimethylpentane. At 550° C. 2 : 2 : 4-trimethylpentane was converted into 25% aromatics, but this conversion was accompanied by extensive cracking. Desulphurization and aromatization of benzole fractions were found to be technically inseparable processes. The activities of various catalysts for desulphurization were studied. Molybdenum sulphide showed greater activity than chromium sulphide, except when the former was prepared outside the catalyst tube.

In general, the cyclization of hydrocarbon mixtures results in a spreading of the distillation curve, formation of gas and carbon, and an increase in aromatic and unsaturated hydrocarbons. At the same time hydrogenation reactions take place. The product from such a reaction will therefore depend on the conditions of the reaction and on the nature of the substrate. By the choice of suitable conditions, and by varying the composition of the substrate, it is possible to achieve several different reactions at the same time, using a single catalyst.

The paper is appended with 46 references to the literature. A. H. N.

1101.* The Separation of Gases. M. Ruhemann. *J. Inst. Pet.*, October 1942, **28** (226), 215–239.—Separation of gases necessitates the introduction of another phase

into the single-phase, multi-component gaseous mixture. This is performed either by introducing liquid or solid absorbent phases or by the liquefaction of the gas itself into a two-phase system. The methods of achieving these purposes are given.

Problems of separating the constituents of air and of coke-oven gases are studied specifically. The paper is appended with 13 references and a discussion covering pp. 231–239. A. H. N.

1102. Patent on Chemistry and Physics. M. De Groote. U.S.P. 2,295,163, 8.9.42. Appl. 21.3.41. Process for breaking petroleum emulsions of the water-in-oil type characterized by subjecting the emulsion to the action of a demulsifying agent consisting of a water-soluble esterification product derived by reaction between one mole of a polybasic compound and two moles of a water-insoluble hydroxylated compound. The polybasic compound is the esterification product of (*a*) a polyalkylene glycol having between 7 and 17 ether linkages and the alkylene radical thereof containing from 2 to 6 carbon atoms; and (*b*) a polybasic carboxy acid having not more than 6 carbon atoms. The water-insoluble polyhydric material is a hydroxylated fractional ester derived by reaction between a detergent-forming monocarboxy acid having from 8 to 32 carbon atoms, and a polyhydric alcohol having from 2 to 12 carbon atoms. H. B. M.

Analysis and Testing.

1103.* Laboratory-Size Continuous Distillation Unit. R. W. Hufford and H. A. Krantz. *Industr. Engng Chem.*, 1941, **33**, 1455.—Constructional details are given for a laboratory scale continuous distillation unit having a fractionating column equivalent to 55 theoretical plates. The equipment is fabricated of metal, and the normal operating feed rate is 1 litre/hr. when employing a 3 : 1 reflux ratio. J. W. H.

1104.* Front-End Volatility of Gasoline Blends. N. B. Haskell and D. K. Beavon. *Industr. Engng Chem.*, 1942, **34**, 167.—A graphical method is presented enabling the volatility as measured by the A.S.T.M. 10% point and Reid vapour pressure of refinery gasolines to be predicted from a knowledge of the C_4 and C_5 content of the blend. A correlation is given relating A.S.T.M. distillation loss to the C_4 and C_5 content of the stock. J. W. H.

Motor Fuels.

1105.* Gasoline Additives. J. A. Moller. *Oil Gas J.*, 26.3.42, **40** (46), 82.—Curves, showing (*a*) how increased compression ratio gives increased power output, (*b*) how compression ratios and octane numbers of fuels have risen during the last decade, and (*c*) fuel octane-number requirements against compression ratios, are used to indicate why present-day engines necessitate fuels of higher octane number than formerly. Improving performance by advancing the spark also leads to increased octane-number requirements, as is shown by graphs of spark advance against fuel octane number necessary at different engine revolutions. A series of curves of standard and optimum spark advance for some 1941 passenger cars show that the optimum spark advance is not available to engine manufacturers because of the lack of commercial fuel which would perform satisfactorily. Increasing the air/fuel ratio in the interests of economy must also be paid for in higher anti-knock fuel quality.

The above relates to new engines, but the factors of wear and deposition in used engines again necessitate higher octane ratings of the fuel. The conclusion is reached that due to deposition the designer must arrange for an engine-fuel requirement of 7 octane numbers less than the commercially available fuel he intends the engine owners to use.

In a study of deposition (meaning total deposition including lead compounds, foreign materials such as road dust sand, etc., and carbonaceous matter) combustion-chamber volumes were periodically measured and piston crowns photographed and weighed, etc. Octane requirements of engines were found to increase gradually with use until an equilibrium was reached, and this is accounted for by a "deposition-cycle" theory. Types of deposit are illustrated and classified; as the compression

ratio is increased the quantity decreases, but the deposit becomes of a type more difficult to handle. For each speed and set of loading conditions there is considered to exist a different set of "deposition equilibria," and any additive which will maintain the deposition equilibrium below that which would otherwise be attained leads to a saving of power. Additives should also help to maintain clean valves, etc. Curves are presented showing how the addition of very small amounts of suitable additives can bring the octane requirements of an engine back to almost those of the new engine.

Spraying suitable materials into the combustion chambers through the carburettor while the engine is idling, and later through the spark-plug holes, allows soaking into the deposit, thus aiding in its removal. This temporary purging treatment may cause an immediate reduction in octane requirements of the fuel, which may be maintained by the use of the proper additive to the fuel. The additive must be of such a nature as to leave no residue itself, but the author does not reveal the nature of the additives the effects of which he describes. J. C.

1106.* Propane—A Substitute for Butane in Motor Fuels. R. C. Alden, H. M. Trimble, L. A. McReynolds. *Oil Gas J.*, 26.3.42, **40** (46), 80.—The 100,000 brl. of butane now present in gasoline, if all diverted for aviation gasoline, synthetic rubber, etc., could be replaced by 28,000 brl. of propane to get gasoline of equal Reid vapour pressure. In actual fact a 50–75% realization of such a diversion would be the practical maximum. Propane cannot be exactly equivalent to butane, but propanized gasoline is better than gasoline containing nothing lighter than C_5 hydrocarbons.

Investigations were carried out with various butane-free fuels, and blends of these with propane and with *n*-butane in varying proportions. Probable vapour-locking temperatures, deduced from v.p. and front-end A.S.T.M. distillation characteristics, are considerably higher for propanized fuels than for butanized fuels of equal v.p. "Possible" and "easy" starting temperatures were also deduced, and it was shown that whilst these temperatures are higher for the propanized than for the butanized fuel, they are lower than for gasoline containing no volatilizing agent, typical figures being − 33° F., − 25° F., and − 4° F., respectively, for possible starting with winter fuels.

Since the light hydrocarbons have high octane numbers, removal of butane would increase T.E.L. consumption, on the average, by about 25%, but when propane is substituted the necessary increase is only about 9%.

A few accelerated laboratory tests to measure relative evaporation losses led to the conclusion that under the majority of storage conditions the butanized gasoline would lose volume faster than the propanized gasoline of equal v.p.

In the case of 4% propane inclusion for winter gasoline, difficulty might be encountered with the archaic specification of 95% minimum A.S.T.M. distillation recovery, which, although meaningless, is still in force in several States. J. C.

1107.* Performance Value of High Octane Aviation Gasoline. G. A. C. Leaver. *Oil Gas J.*, 26.3.42, **40** (46), 88.—The advantage of high-octane rating in aircraft fuel is demonstrated by a curve of octane number against brake mean effective pressure, whilst it is emphasized that detonation in aircraft engines may be much more disastrous than in car engines. High-octane fuels are usually blends of special prpducts, and the relevant physical properties of the most important of these are tabulated. Volatility must be controlled for best performance, whilst Reid v.p. must be kept below 7 lb. to guard against possible vapour lock. A combination of low specific gravity and high calorific value increases the range or load capacity of a machine, which eliminates ethanol as an aviation fuel.

The polymerization processes for the preparation of high octane gasolines are discussed simply, from a theoretical view-point, and formulæ of some paraffin hydrocarbons and octane numbers are given to show the effect of molecular structure on octane number.

The article concludes with brief references to some blending agents—viz., *iso*pentane, *iso*propyl ether, and *neo*hexane. J. C.

1108. Trend in Aviation Gasoline Processes Towards Fuels of Fewer Compounds. G. Egloff. *Nat. Petrol. News*, 15.4.42, **34** (15), R.120.—The current trend in the de-

velopment of aviation fuels is to reduce the number of hydrocarbons present in the fuel. Processes such as polymerization, alkylation, dehydrogenation make it possible to control the proportion of a particular hydrocarbon produced. The author states that the ideal fuel would be a pure hydrocarbon, which would give a far greater power output than any gasoline known to-day. Flow-sheets and brief descriptions are given of the *iso*-octane process, alkylation process, isomerization process, together with that of a polymerization unit. H. G.

1109.* Practical Application of Gas Producers to Road Transport, Including Passenger Service Vehicles. S. G. Ward and W. J. Morison. *J. Institute Fuel*, June 1942, **15** (84), 131.—A long, comprehensive paper discussing the general application of portable gas-producers to road transport and the results in their development jointly achieved by the Tilling group of omnibus companies and the University of Birmingham. The conclusion is reached that much greater numbers of vehicles can now be converted with confidence, and so help to ease the present liquid fuel position.

As home-produced alternatives to imported fuel acetylene, hydrogen, and methane suffer from various disadvantages, whilst town's gas, either at low or high pressure, is unsuitable for large-scale expansion, one reason being dependency on the uninterrupted functioning of gas-works.

Portable gas-producers and the fuel they yield have disadvantages, among which are the high weight of the ancillary equipment, the low calorific value of the gas, and the necessity for its purification, the loss of engine power involved, the difficulties of handling solid fuels, and the necessity for regular servicing. Advantages are that sufficient fuel can be carried to give the vehicle a wide range, reliance is not placed on a few large gas-producing centres, the fuel cost per mile is lower than for petrol, and that diesel vehicles, modified to operate by spark ignition, can be converted. These far outweigh the disadvantages when compared with other possible replacement fuels.

The main gas-producer designs are classified, and a list of types manufactured in this country is given, with references. With all systems the primary reaction is the formation of CO by incomplete combustion of the carbon of the fuel. Some secondary reactions, such as the formation of CH_4 from water vapour and carbon, are desirable, whilst the main undesirable secondary reaction is that yielding CO_2. The reactions involved and the properties and compositions of the gases obtained in the dry-blast and the wet-blast (water or steam injection) systems are discussed in detail. The ratio CO to CO_2 is dependent on time, temperature, etc., and a table is given of typical ranges of gas compositions for anthracite and for low-temperature coke.

The gas leaving the producer contains the major fuel constituents CO, CH_4, and H_2, the diluents CO_2, O_2, and N_2, variable proportions of H_2S, organic sulphur compounds, cyanogen compounds, free and combined ammonia, tarry matter, suspended solids, and water vapour.

The excessive cylinder wear obtained with producer-gas is shown by experiments with wet scrubbers and by service practice to be due, not primarily to abrasion by fine dust passing the fairly efficient commercial filters, but mainly to the corrosive gaseous impurities which such dry filters do not arrest. These gaseous impurities may corrode cylinders either by deposition of solutions of soluble ammonia and sulphur compounds on the walls, or by sulphuric, nitrous, and nitric acids formed in the cylinders by combustion in the presence of water. The desirable attributes of gas cleaners are discussed and summarized, and from theoretical reasoning it is considered that one of the best systems is to pass the gas through a cyclone or similar device to remove coarse dust, and then through a water-washer to remove ammonia, sulphur compounds, and finer dust.

Filters, washers, and other parts of producer units have been examined by bench tests, road tests, and extensive service tests.

With the bench-test plant the dust content of filtered gas was determined by means of an electrostatic precipitator, and the efficiencies of several different designs of wet washers, oiled filters, etc., were compared. Laboratory investigations included examination of fuels, clinkers, cooler deposits, washer or filter deposits, wash-waters, gas system and engine deposits, etc., whilst laboratory tests were also made with small producers to study the effects of such variables as fire-bed conditions, temperature of gas at the washer inlet, and fuel treatment on the removal of sulphur

compounds from the gas. Road tests were carried out with an omnibus, equipped with a suitably modified Leyland Tiger engine and a trailer carrying a producer, cooler, and gas-cleaning plant. Optimum conditions for removal of S and NH_3 were determined by testing with different types of wet-washer, cooler and cyclone, with wet- and dry-blast, with different fuels; the effect of wetting agents on the wash-water was also determined. The conclusion is reached, *inter alia*, that under the best conditions the gas entering the engine has a sulphur content of about 10 gm. per 1000 cu. ft., and at the worst about 20 gm. The wet-washer not only reduces the S content, but removes most of the NH_3.

Developments on service vehicles, mostly of 7–8 litres capacity, have also provided much data, and not until wet-washers were used were good cylinder-wear figures obtained. A full description, with diagrams, is given of the plant now used and also of the service routine. Figures for cylinder wear average about 4000 miles per thousandth of an inch, and are comparable to those obtained when similar vehicles operate on petrol. Upper cylinder lubrication and soda doping of the anthracite fuel reduced cylinder wear and total fuel costs were 1·67*d.* per mile, as against 2·75*d.* per mile for petrol and 1·52*d.* per mile for diesel oil.

Of the fuels available in this country, anthracite is considered generally superior to low-temperature and to activated gas coke. A highly reactive dust-free fuel of suitable size is required to give easy lighting, good performance, and desirable flexibility; it must not form tar; it should be low in ash, S, N_2, and Cl_2; it should be resistant to shatter and abrasion; the ash should not give rise to clinker troubles; it should have high bulk density and uniformity of properties.

The present position is discussed in relation to costs of conversion and availability of fuel supplies and, on the results of experience, detailed recommendations are made of the type of plant required for conversion of passenger vehicles, goods vehicles, and municipal service vehicles. Possible applications of portable gas-producers, other than for essential transport, are listed.

The article concludes with a discussion of future developments and points which require further investigation, whilst a short description is given of vehicles which are being made specifically to operate on producer-gas.

Numerous diagrams, graphs, and tables of numerical results are included.

J. C.

1110.* The Examination of Ethyl Alcohol and Alcohol Blends for Use as Motor Fuel. S. J. W. Pleeth. *J. Inst. Pet.*, October 1942, **28** (226), 240–256.—Details are given about the testing and properties of ethyl alcohol and alcohol blends for use as motor fuels. Precautions to be taken in certain tests—*e.g.*, vapour-pressure tests—when dealing with alcohol blends, are particularly stressed. A. H. N.

1111. Patents on Motor Fuels. Texaco Development Co. E.P. 547,457, 28.8.42. Appl. 8.6.40.—Isomerization of straight-chain paraffin hydrocarbons of gasoline boiling range to produce corresponding *iso*paraffin hydrocarbons. The paraffin hydrocarbons substantially free from olefin and aromatic hydrocarbons are contacted with a metallic halide isomerization catalyst and maintained under isomerization conditions. The isomerization reaction is effected in the presence of added *iso*butane or *iso*pentane in an amount by weight which is substantially in excess of the paraffin hydrocarbons undergoing conversion. In this way catalyst deterioration is substantially reduced.

R. E. Schaad. U.S.P. 2,295,808, 15.9.42. Appl. 13.9.40. Production of anti-knock motor fuel from substantially saturated hydrocarbon oil. The oil is subjected to catalytic destructive hydrogenation to produce a substantial quantity of *iso*butane. From the resultant products are separated an *iso*butane fraction and a fraction higher boiling than hexane. The last-named fraction is subjected to catalytic dehydrogenation to form normally liquid olefins. These are mixed with the *iso*butane fraction, and the product subjected to catalytic alkylation to react olefins with *iso*butane. The resultant alkylate is recovered.

G. W. Talbert and E. W. Blizzard. U.S.P. 2,296,069, 15.9.42. Appl. 21.3.40. Preparation of a hydrocarbon fuel for use in an internal-combustion engine and con-

taining a small amount of a higher alkyl aryl sulphonate in which the aromatic nucleus contains not more than 2 nuclei and the higher alkyl substituent has from 20 to 30 carbon atoms joined carbon to carbon.

F. E. Frey, P. V. McKinney, and W. H. Wood. U.S.P. 2,296,511, 22.9.42. Appl. 27.6.36. Continuous process for reacting paraffins of low molecular weight with normally gaseous olefins to produce predominantly paraffinic oils in the motor-fuel boiling range and of higher molecular weight.

V. R. Kokatnur. U.S.P. 2,296,558, 22.9.42. Appl. 20.9.38. Preparation of a motor fuel consisting of an organic combustible material of high flash and high boiling point and a true peroxidic compound of fatty acids which is soluble in the oil.

R. B. Thompson. U.S.P. 2,297,114, 29.9.42. Appl. 24.6.40. Production of gasoline containing a small proportion of lead tetraethyl which normally tends to decompose on storage, and as a stabilizer, a small quantity of an alkyl amine salt of an alkyl pyrophosphoric acid ester. H. B. M.

Gas, Diesel, and Fuel Oils.

1112.* Determining Fuel Oil Heat Losses. W. F. Schaphorst. *Petrol. Engr*, June 1942, **13** (9), 127.—Several years ago a chart was prepared by this author on fuel heat losses relating to coal only. This has now been converted to fuel oil, the chart being based on the formula

$$L = \frac{0{\cdot}08(5CO_2 + 700)C(T - t)}{CO_2H}$$

where L = % fuel loss.
CO_2 = % CO_2.
C = % carbon in fuel.
T = temp. of outgoing flue gas.
t = temp. of air entering the furnace.
H = B.Th.U. per lb. fuel.

An example of the working of the chart is given. D. L. S.

Lubricants and Lubrication.

1113.* Extreme Pressure Lubricants. G. L. Simard, H. W. Russell, and H. R. Nelson. *Industr. Engng Chem.*, 1941, **33**, 1352.—The film-forming action and use of lead naphthenate and free sulphur in extreme-pressure lubricants for use with hypoid gears is discussed. From measurements of the film-forming action by means of an electron diffraction camera it is shown that the addition of these agents resulted in greater film-forming tendencies in unrefined oils than in refined oils. The formation of iron oxide and lead sulphate shows that oxygen must be included in considering the chemistry of E.P. lubricants.

The data from which the foregoing conclusions have been drawn are based on laboratory static and friction tests and on actual service tests on hypoid gears. J. W. H.

1114.* Properties of Synthetic Lubricating Oils. E. Neyman-Pilat and S. Pilat. *Industr. Engng Chem.*, 1941, **33**, 1382.—Seven new liquid hydrocarbons of the aromatic and naphthenic series containing 22 carbon atoms per molecule have been synthesized and their physical properties determined for comparative purposes with similar data obtained on petroleum fractions in order to correlate physical properties with chemical structure. J. W. H.

1115.* Oxidation Characteristics of Pure Hydrocarbons. R. G. Larsen, R. E. Thorpe, and F. A. Armfield. *Industr. Engng Chem.*, 1942, **34**, 183.—The oxidation characteristics of some 40 pure hydrocarbons over the temperature range 110–150° C. have been determined by analysis of the oxidized oils for oxidation products and by analysis of the volatile products formed. Analyses include acidity, saponifiable matter, carbonyl values, alcohol and peroxide determinations, and examination of the volatile products for CO_2, water, and acids.

It is concluded that paraffins and *cyclo*paraffins are quite reactive, simple aromatics are still more reactive, but that polynuclear aromatics and naphthenes are very stable, due to the formation of oxidation inhibitors during the oxidation.

It is also concluded that the oxidation stability of lubricating oils is not due to the stability of their component hydrocarbons *per se*, but to their oxidation inhibitor content. J. W. H.

1116.* Superfinish and its Effects on Lubrication. J. Devon. *Petroleum*, February 1942, **5** (2), 31.—Surfaces which were once thought to be perfectly smooth are now known to consist of a regular series of jagged edges. Our knowledge of the nature of these surfaces has been considerably assisted by the use of the profilometer, which is capable of measuring projections to a millionth of an inch. This has shown that the scratch depth for various machining operations in micro inches are: Turning 50/500, grinding 35/250, burnishing 10/550, honing 5/50, lapping 3/10, microfinish 0·5/10.

Superfinish is produced by an additional operation following the final dimensional precision operation. It is a species of controlled machine lapping or honing in which the laps or hones travel the whole surface in a slightly spiral path, which spiral is reversed before the end of each stroke. Each stroke commences at a different point, so that no cutting points of the laps follow the same paths they have already travelled.

The use of superfinish applied to pistons and cylinders of cars is to produce a new article with a surface equal to that after 1000 miles running-in. It is also claimed that its adoption will make lubrication a much simpler and more effective operation. D. L. S.

1117.* Uses and Limitations of Filtration as a Means of Recovery of Waste Oil. A. H. Stuart. *Petroleum*, March 1942, **5** (3), 49–50.—A few years ago the only filter found in the lubricating system of an I.C. engine was a fine-wire gauze strainer capable of removing only very coarse particles. Filtration of oil in the system has now been much improved, and it is possible to obtain a filtrate free from dirt and from a proportion of the oxidation products formed during use.

In the reclamation of used oil it is necessary to remove particles of very small dimensions, and adsorptive principles are frequently employed. This type of filtration is without effect on mineral oil, but is apt to remove the polar constituents often added to increase oiliness. Thus an oil reclaimed by adsorptive filtration may be in excellent condition, and yet weak in the components essential for efficient lubrication.

In reclamation by filtration the oil is usually heated before processing to reduce its viscosity, and this may have the effect of increasing the solubility of the sludge in the oil, and thus allowing it to pass the filter.

It is concluded that the filtering of used oil by small users by means of modern filters is well worth while if it is remembered that the filtrate may not be quite up to the standard of the new oil. D. L. S.

1118.* Are so many Varieties of Lubricants Really Necessary? A. T. Wilford. *Petroleum*, June 1942, **5** (6), 94–98.—This article discusses the possibility of simplification of grades of lubricants in the interests of both users and suppliers.

Three main considerations arise in selecting a lubricant for a particular application—quality, viscosity (or consistency for a grease), and price.

Quality is not easy to define, and depends to a great extent on the conditions under which the lubricant is to be used.

Viscosity can be precisely defined, but the value at one temperature only is of limited use. Viscosity index should therefore always be determined.

Price is related to both quality and physical characteristics, but, in general, the selected lubricant will be the cheapest one capable of doing the job.

In choosing an oil for a particular application, users are greatly influenced by the recommendations of the manufacturers of the plant or vehicle concerned, and in practice are often led to stock an unnecessary number of grades, each for some particular piece of plant.

The author considers the S.A.E. and B.S. classification of lubricants, which is solely on a viscosity basis. He does not consider viscosity to be very critical in the operation of road vehicles, oils ranging from 120 to 300 sec. Red. I at 140° F. giving apparent satisfaction.

In special cases viscosity of oils or consistency of greases may have to be limited to within a fairly narrow range, but in the majority of cases a fairly wide variation can be allowed, both for transport vehicles and for industrial use. Some simplification is therefore possible, and it is shown that oils marketed for some particular purpose can be successfully utilized for a number of other applications.

Greases have been considered from the same angle, and the author is of the opinion that here also a reduction in the number of grades can be justified. D. L. S.

1119. Plain Bearing Lubrication of Machine Tools. E. Worthington. *Petroleum*, September 1942, **5** (9), 152.—Systems of lubrication fall broadly into two types, (*a*) some form of gravity feed, (*b*) pressure-feed arranged either for intermittent or continuous operation. Typical lubrication systems are illustrated and their method of operation described. The gravity-fed spindle bearing is designed for light load and speeds up to 10,000 r.p.m., and requires a spindle oil of 27·7 A.P.I. grav., viscosity S.U. at 100° F. 105 secs., at 210° F. 45 secs.

The high-pressure intermittent feed systems have been found efficient in practice, particularly for lower speed shafts, slides, and handle-operated mechanisms, but elaboration of piping is on occasion too great for war-time application. The continuous pressure-feed system is normally limited to peripheral speeds of 2000 r.p.m. The sealing of the ends of the bearing needs special investigation for higher speeds.

The class of lubricant employed is a light oil consisting of 1 part spindle oil and 3 parts kerosine. R. A. E.

1120. A Standardization Scheme for Mineral Lubricating Oils. G. J. C. Vineall. *Petroleum*, September 1942, **5** (9), 148.—Suggestions are presented in respect of a scheme for standardization of industrial lubricants, the oils being separated into grades depending on viscosity Redwood I, into classes based on viscosity index, and into qualities depending on special requirements for specific purposes. A system of nomenclature which would include the three divisions is also presented. It is considered that the standard test methods of the Institute of Petroleum and the A.S.T.M. should be adopted in any system of standard classification. As regards grades, capital letters are suggested, *A* to *I* covering a total viscosity range in terms of Redwood I at 140° F. from under 45 up to 500 secs., and *W* to *Z* a range at 200° F. from 100 to above 210 secs. The basic quality specification suggested is: S.G. at 60° F., 0·850/0·960; flash point P.M. closed, Grades *A*/*I* 300° F. min., Grades *W*/*Z* 500° F. min.; pour test, Grades *A*/*I* 30° F. max., Grades *W*/*Z* 80° F. max.; mineral acidity nil, organic acidity 0·2 mgm. per gm., saponification value 1, asphaltenes Grades *A*/*I* 0·05% max., Grades *W*/*Z* 1·0% max. Roman numerals I to III are proposed for indicating viscosity indices, Class I covering oils of over 80, Class II oils of 50–80, and Class III oils under 50. Special qualities could be indicated by small letters—*e.g.*, *p* could denote refrigeration oils having a max. pour point of − 25° F., *o* oils which, after Air Ministry oxidation, show an increase in coke value of under 1 and a viscosity increase ratio of under 2, and *a* an asphaltene content of max. 0·1%. The special qualities proposed for classification are based on limitations in respect of colour, pour test, carbon residue, oxidation, demulsification, and asphaltenes. It is recommended that no limitation as regards composition should be imposed in any general specification. It is suggested that motor oils and compounded oils could be incorporated within the scope of the scheme proposed, but that the use of addition agents should be regarded as a matter between supplier and consumer. Conventional laboratory test methods may not enable definite evaluation of service performance of an oil for a particular use, but are currently used as a basis for manufacture and specification, and it is felt that a codification of oils on the lines proposed would be of value as a guide to users and suppliers. Additional specific requirements could be superimposed. R. A. E.

1121. Patents on Lubricants and Lubrication. Standard Oil Development Co. E.P. 547,972, 21.9.42. Appl. 17.11.39. Preparation of a lubricant consisting of a hydrocarbon lubricating oil compounded with a metal salt of a dihydroxy dialkyl diaryl sulphide or polysulphide or polymers of such compounds, or selenide or telluride analogues.

Standard Oil Development Co. E.P. 547,973, 21.9.42. Appl. 17.11.39. Process for the preparation of a lubricant consisting of a hydrocarbon lubricating oil and a small proportion of a metal salt of an alkyl phenol containing a nitro-, amino-, or alkyl-substituted amino-substituent group in the aromatic nucleus.

Standard Oil Development Co. E.P. 548,038, 23.9.42. Appl. 17.4.40. Preparation of a lubricant consisting of a hydrocarbon lubricating oil and a small proportion of a ketonic compound.

R. Rosen and R. M. Thomas. U.S.P. 2,295,053, 8.9.42. Appl. 19.7.38. A lubricant consisting of a well-refined hydrocarbon oil to which has been added less than 2% of an organic trisulphide to increase resistance of the oil to oxidation.

C. M. Loane. U.S.P. 2,295,179, 8.9.42. Appl. 26.10.40. Preparation of a lubricant consisting of a lubricating oil and the reaction product of a phosphatidic material and an aromatic amine at temperatures below 300° F.

M. H. Arveson. U.S.P. 2,295,192, 8.9.42. Appl. 26.10.40. Preparation of a lubricant consisting of a lubricating oil and from 0·01% to 5% of the reaction product of a hydrogenated phosphatidic material and an organic amine at temperatures below 300° F.

W. J. Sparks and D. C. Field. U.S.P. 2,296,315, 22.9.42. Appl. 18.10.38. Preparation of a lubricant consisting of a lubricating oil containing a co-polymer of an eleosterin and an olefine. H. B. M.

Asphalt and Bitumen.

1122. Asphalt Paving Emulsions Properties, Uses, and Tests. E. J. Barth. *Refiner*, August 1942, **21** (8), 232–239.—A brief history of the use of asphalt emulsions is given, followed by their general uses for waterproofing, rotproofing, and paving. Emphasis is laid in the paper on the use of asphalt emulsion as paving material. Fast, medium, and slow breaking emulsions are described, and their uses in different types of roads are summarized. Emulsifying agents are listed under organic and inorganic headings. (A) Organic: This group includes water- or oil-soluble soaps, such as soaps of sulphonated petroleum, fatty oils of vegetable or animal origin, and naphthenic acids; proteins, rubber, amines, casein, procein, fatty acids, and their metallic soaps; oxidized paraffin wax-acids, rosin, tannates, waste products from the paper industry, such as waste sulphite liquor, and tall-oil, and other miscellaneous materials usually in the form of soaps containing one or the other above materials. (B) Inorganic: This group comprises alkalis, ammonia, various salts such as the silicates, phosphates, hydroxides, and colloidal material such as hydrous oxides, hydroxides, bentonite, clays, and materials of that type; Portland cement, etc.

The characteristics of different types of asphalts used for emulsification are discussed in some detail. Bitumen consists of four empirically designated hydrocarbon groups: asphaltenes, asphaltic resins, oil resins, and the oils. The asphaltic resins and the oil resins are now commonly included under the name of "resins." Asphalt itself when it is practically a pure bitumen is a dispersion of high-molecular-weight hydrocarbons or asphaltenes; this component is of low hydrogen content, and recent determinations show the molecular weight of this fraction to be approximately from 10,000 to 140,000 molecular weight. The characteristics of asphaltene are studied. This is followed by the study of the rôle of the emulsifying agent in the emulsions under two groups: (1) The commonly employed emulsifiers are oil- or water-soluble substances, typified by the soaps of monovalent metals. These emulsifiers act as such due to their property of lowering the surface tension of either the asphalt or the water. The general rule has been that when the soap is more soluble in water than in asphalt, such as sodium oleate, an asphalt-in-water emulsion is formed; if the emulsifier is more soluble in the asphalt, such as calcium or magnesium oleate, a water-in-asphalt emulsion most generally forms; it has also been found that the component most completely wetting the compound, or emulsifier, will be the external phase in the emulsion. The solubility rule is a good rule to follow, although it has probably many exceptions.

(2) The second type of emulsifying material is that which is either wetted by one component more than the other, is practically insoluble, or only slightly soluble, in both phases, affects the surface tension only slightly, and forms plastic adsorbed films on the dispersed asphalt particle, or around the water particle, due to peptization and swelling. Under this group are the materials most commonly used to be colloidal clays, such as bentonite, various oxides, silicates, Portland cement, ground slag, certain salts of the heavy metals, etc. Emulsions formed with these types of materials show greater stability than those containing emulsifiers of the first group, are known to "break" at a much slower rate, and then only mostly when the water in the emulsion has begun to evaporate. Emulsions containing the second group of emulsifiers are not sensitive to the presence of foreign substances, dissolved salts, and changes in the electrical charges of the dispersed particles do not cause the emulsion to "break." This type of emulsifier produces, with or without soaps, "slow break" emulsions which are quite stable.

A study of the effects of particle size and of p_H values on storage and liability of asphalts and of methods used in determining these two criteria ends the paper. The bibliography contains 45 references. A. H. N.

1123. Asphaltic Substances in Crude Oils. G. W. Preckshot, N. G. DeLisle, C. E. Cottrell, and D. L. Katz. *Petrol. Tech.*, September 1942, **5** (5), A.I.M.M.E. Tech. Pub. No. 1514, 1–18.—Most crude oils contain asphaltic substances which may be naturally or artificially precipitated. Oil samples for examination by means of the electron microscope at magnifications of 1200–23,000, or even more under photographic enlargement, were placed on a collodion film either as a dilute oil solution from a small pipette or from an undiluted thin oil film on water. Evaporation of oil and solvent took place from the collodion film mount. Rounded asphaltic particles ranging 0·01–0·20 microns in diameter were obtained from various oils.

A Californian crude which had not been diluted or washed, but which was under a pressure of less than 10^{-4} mm. of mercury, apparently did not show asphaltic particles. The particles seem to be precipitated by dilution or washing with solvents such as benzene. In the original crudes, the asphaltic substances must occur as dispersed molecules, or as an association of a relatively small number of molecules, dependent on the molecular weight of the asphaltic compounds.

A sample of the Greeley crude showed no signs of the precipitation of asphalt on reduction from reservoir pressure and temperature to surface conditions. Electrodeposition of asphaltic particles took place on the negative electrode. Very little bitumen was thrown out of solution on centrifuging. Streaming potentials arising from the flow of oil through a porous medium precipitated asphaltic particles from the Californian crude. Crude flowing through a sand developed a potential across the porous mass, and asphaltic particles appeared in the oil after passage through the sand. G. D. H.

1124. Patents on Asphalt and Bitumen. J. F. Sterling. E.P. 547,530, 1.9.42. Appl. 19.3.41. Method of hardening and improving bitumens, asphalts, and other bituminous materials, including asphalt mastics, tars, pitches, and/or mixtures thereof. The bitumen or other material is treated while in molten state with one or more metallic nitrates capable of acting as oxidizing agents.

S. S. Sorem. U.S.P. 2,295,974, 15.9.42. Appl. 29.6.40. Method of improving the bonding power of an asphalt towards a metallic surface normally corrodible by asphaltic acids. Added to the asphalt is a small amount of a salt combining a volatile organic acid with a metal. The soaps of the metal with the asphaltic acids are no more water-soluble than those of zinc. Finally, the asphalt is heated to expel volatile acids. H. B. M.

Special Products.

1125.* The Development of Cutting Oils. A. H. Stuart. *Petroleum*, June 1942, **5** (6), 100.—In assessing the performance of any machine-tool operation, a more than usually large number of variables has to be considered. These must all be standardized and kept constant if an investigation of the properties of different cutting fluids is under consideration.

No liquid can be found which will be equally satisfactory in all circumstances, but it is helpful to list the properties which such a fluid should possess.

(*a*) Since the pressure exerted by the tool is high (50–150 tons per sq. in.), such a force operating at cutting speed generates heat which must be conducted away quickly. Thus high specific heat and latent heat and good thermal conductivity are essential.

(*b*) Wetting ability is important, as otherwise the liquid may be prevented from acting as a coolant.

(*c*) Lubrication properties are essential, especially to reduce the friction between the hot strip of swarf and the raked surface of the tool.

Other properties which such an oil must possess are a sufficiently high flash point, stability to oxidation, non-corrosiveness, and low viscosity.

Cutting fluids have therefore to meet all or part of the above requirements. If cooling only is necessary, a blast of air may be satisfactory. For greater cooling, water or an aqueous alkaline solution may be used. When lubrication is important, soluble oils may be necessary. Finally, when even greater lubrication is required, straight oils containing E.P. additives must be used.

Colloidal graphite dispersed in mineral oil is also stated to have applications in this sphere. D. L. S.

1126.* Synthetic Rubber—A Bibliography. Anon. *Petrol. Engr*, June 1942, **13** (9), 45.—A bibliography dealing with the synthesis of rubber divided into the following sections: General, Acrylonitrile, Advagum, Ameripol, Buna, Butadiene, Butyl Chemigum, Chemistry, Flextite, Gas Industry, Hycar O.R., Koroseal, and Neoprene. D. L. S.

1127. Five Steps for Making Butadiene in Thermal Cracking Furnaces. Anon. *Nat. Petrol. News*, 5.8.42, **34** (31), 18, 38.—In the immediate programme for the production of butadiene five methods which can be carried out in existing equipment are being considered. Catalytic processes for the dehydrogenation of butane and butylenes are under consideration. The five methods are: (1) Direct thermal cracking in tubes; (2) preliminary heating in tubes with additional heat supplied by superheated steam; (3) as in (2) with hot flue gases replacing steam; (4) preliminary heating in tubes with additional heat supplied by air injection; (5) thermal cracking on heated brickwork after preliminary heating in tubes. In all cases the optimum temperature is approximately 1400° F. and, in general, operation is limited to those plants equipped with heat-resisting alloy steel. The average yield in one pass operation is approximately 5%. H. G.

1128. Patents on Special Products. Standard Oil Development Co. E.P. 547,730, 9.9.42. Appl. 6.9.40. Method of separation and concentration of butadiene from a mixture of saturated and unsaturated hydrocarbons. After the mixture of gases has been contacted with an absorbent cuprous chloride solution, the absorbent with absorbed butadiene separated, and the butadiene recovered, the butadiene is contacted with another fraction of the same absorbent solution. The solution containing re-absorbed butadiene is separated and the butadiene recovered from it.

G. R. Gilbert and A. A. Peer. U.S.P. 2,295,035, 8.9.42. Appl. 20.5.39. Preparation of a petroleum oil dye by extracting a petroleum oil boiling in the range 360–540° F. with sulphur dioxide under conditions designed to form a solvent extract phase and a raffinate phase. The solvent extract phase is removed and the sulphur dioxide separated from it. The extract is cracked to produce a cracking coil tar having a gravity from 2° to 6° A.P.I. The cracking coil tar is de-asphalted by the addition of a diluent. Then the de-asphalted tar is separated and extracted with a selective solvent of the class having preferential selectivity for the more aromatic type compounds. Thus are formed a solvent phase and a raffinate phase. The latter is separated and the solvent removed from it. The solvent-free raffinate is distilled and an improved petroleum dye recovered as residue. H. B. M.

Detonation and Engines.

1129.* The War and Patents Relating to Internal-Combustion Engines. S. T. Madeley. *Gas Oil Power*, October 1941, **36** (433), 191.—A graph is given showing the approximate number of patents granted for the period 1910–1940 relating to (*a*) carburetting, vaporizing, and heating apparatus, (*b*) ignition apparatus, (*c*) valve-gear and injection equipment.

Curves (*a*) and (*b*) show peaks caused by the booms of 1913 and 1932 and that due to the recovery after the 1914–18 war. The depressions of 1916 and 1927 are also very marked. Curve (*c*), which is illustrative of the compression-ignition engine development, is very consistently level between slight peaks.

A few recent examples of patents relating to different aspects of the internal-combustion engine are quoted. The position of patents during the war period is discussed. D. L. S.

1130.* Response of Aircraft Fuels to Tetraethyl Lead. A. G. Cattaneo and A. L. Stanly. *Industr. Engng Chem.*, 1941, **33**, 1370.—The lead tetraethyl blending chart which previously only enabled lead responses up to 100 octane number to be estimated has now been extended into the region above 100 octane number, and the basis of the extension is fully discussed. Charts are given which enable the lead response of aviation fuels to be estimated up to *iso*-octane + 3·0 c.c. T.E.L. per gallon from the octane number of the base fuel and a single lead response. J. W. H.

1131. Effect of Ignition Timing and Anti-Knock Quality of Fuel on Engine Performance. C. W. Phelps, R. C. Heidner, and M. L. Smithy. *Nat. Petrol. News*, 15.4.42, **34** (15), R.117.—The article describes a road test in which the relation between ignition timing and tendency to knock was investigated for a number of fuels. It was concluded that the anti-knock quality demand and the wide-open-throttle performance of modern automobile engines are dependent on the ignition timing. Fuels of low ignition quality may be used without excessive detonation if the ignition is retarded sufficiently, but a corresponding reduction in power output results. Some differentiation is made as between engines with low compression ratio heads (6·5/1) and high C.R. heads (7/1 to 7·5/1). H. G.

1132.* Effect of Friction in Air Inlet and Exhaust Systems of Internal-Combustion Engines. Part I. O. Adams. *Petrol. Engr*, June 1942, **13** (9), 33.—The question of air-flow in ducts raises many problems which are puzzling unless certain fundamentals are understood. The general laws of fluid flow are applicable to both liquids and gases. In this case the relationships and conditions that occur in the mechanical form of energy, such as pressure, volume, velocity, and temperature, are concerned, the thermal or chemical form of energy not being important in this connection.

Certain broad general equations for energy relationships of various processes are discussed. D. L. S.

1133.* Spring Tension Balance for C.F.R. Bouncing Pin. P. Draper. *J. Inst. Petrol.*, September 1942, **28** (225), 209–213.—The development of the balance is given. Detailed instructions for its use are included in the paper, which gives a full description of the apparatus. A. H. N.

Economics and Statistics.

1134. Refineries Operating in the U.S.A., Mexico, and Canada. Anon. *Oil Gas J.* 26.3.42, **40** (46), 152, 156, 158.—The refineries operating in these countries are alphabetically listed, according to the state in the U.S.A. and to the province in Canada, and the location, type of refinery, and cracking plant, together with their capacities in barrels, are given. A similar list is given of the shut-down plants in the U.S.A. J. C.

BOOK REVIEWS.

Annual Reports of the Society of Chemical Industry. Vol. XXVI, 1941.

The size of the annual volume of the S.C.I. *Reports of the Progress of Applied Chemistry* is a good yardstick for measuring the number and importance of the technical developments made public during the year under review. Under present conditions much work necessarily remains unpublished and yet this latest volume is almost as bulky as its forerunners. Much of the work reported was carried out in the U.S.A., though Russian, German, and Swiss journals add their quota, and Japanese sources have not passed unnoticed.

While every professional man will find some portion of the book of interest and value, the chapters "Mineral Oils" by W. W. Goulston, "General, Plant and Machinery" by F. Rumford, "Fuel" by J. Hiles and R. A. Mott, and "Gas, Destructive Distillation, Tar and Tar Products" by H. Hollings and W. A. Voss are of special interest to those engaged in the petroleum industry.

Mr. Goulston surveys the literature dealing with internal corrosion of pipe-lines, the permissible content of certain toxic gases such as hydrogen sulphide in the atmosphere of work-places, and the examination of Californian crude oils by distillation methods, as well as with developments in refining processes and plant, analytical methods, petroleum substitutes, and special products.

Gasoline sweetening by mixed solutizers and by caustic-soda solution–methyl alcohol mixture, improvement of ignition quality of diesel fuels by solvent extraction and reduction in sludging tendency of fuel oils by treatment with sulphuric acid and alkali are among the refining processes mentioned, while new types of plant which have been described include distillation columns containing Stedman triangular pyramid type of packing, a catalytic cracker in which the powdered catalyst is injected into the oil vapour stream and subsequently recovered in a cyclone separator (this principle is applicable also to polymerization, dehydrogenation, and other catalytic processes), and a "hydroforming" unit. The isomerization of normal butane by means of aluminium chloride and the mechanism of the alkylation reaction have received attention, while the oxidation of lubricating oil has been studied and a laboratory method of measuring the tendency to sludge formation developed.

New specifications for aviation fuel have been adopted by the A.S.T.M., and two methods of testing knock-rating of these fuels standardized, one by the A.S.T.M. and one by the I.P. The A.S.T.M. method includes means for control of the humidity of the inlet air, and has just been adopted by the I.P. While on the subject of knocking, reference may be made to a recently patented apparatus which automatically corrects any tendency to knock by adjusting the fuel mixture.

The A.S.T.M. has also published recommended specifications for diesel fuels. The improvement of ignition quality of diesel fuels by means of additives has been studied and compared with solvent extraction methods. Work on diesel fuel additives is also noticed in the chapter on "Fuel."

Research on the nature of the hydrocarbons present in products ranging from the gasoline fraction to asphaltic bitumens has been carried out in U.S.A., where the A.P.I. has also initiated work on the synthesis and examination of hydrocarbons in the range C_{25}–C_{35}. Several quinoline homologues have been isolated from sulphur dioxide extracts of Californian kerosine and gas oil and identified.

Besides the advances in analytical methods already referred to, Mr. Goulston mentions a new laboratory fractionating column, claimed to be equivalent to seventy-five plates for a height of 35 cm., a "mixed aniline point" method for evaluating solvent power, the determination of unsaturateds by titration with a standard bromine solution, new viscometers, including Fenske's modification for opaque oils, methods for determining free sulphur and organically combined phosphorus in lubricating oil, the revised I.P. distillation test for cut-back asphaltic bitumen, and the estimation of paraffin wax in asphaltic bitumen by an extraction method.

The growing importance of natural gas as a raw material for chemical industry is emphasized by Mr. Goulston and by Dr. Hollings and Mr. Voss, while Mr. Dawson, in his contribution on "Rubber," refers to the production of carbon black and

synthetic rubbers. Production of toluene from petroleum is also dealt with by the former contributors: Dr. Hollings and Mr. Voss summarize the U.S. Bureau of Mines investigation of azeotropic distillation.

Mr. Rumford's chapter deals with many subjects of interest to petroleum engineers: these include recent studies of flow, heat transfer, distillation and absorption processes, and boiler-water treatment, which is also covered by Dr. Elsdon and Mr. Gibson in "Sanitation and Water Purification."

This cursory review has of necessity left much unnoted: it behoves everyone who wishes to keep abreast of current developments to study the volume in its entirety.

E. P. DRISCOLL.

Fuel Testing—Laboratory Methods in Fuel Technology. By Godfrey Himus. Published by Leonard Hill, Limited, 17, Stratford Place, London, W.1. Second Edition, 1942. Price .

The first edition of this book was issued in 1932, and in the revised edition just published the methods of analysis and testing originally dealt with have been brought up to date. In this second edition the original introduction and a chapter on coal classification have been omitted, while a chapter on combustion calculations has been added.

The book deals largely with the sampling, testing, and examination of coal, nine out of the fifteen chapters being devoted to this end. Two chapters deal with gas analysis and the calorific values of gases respectively, and one chapter only describes the testing of liquid fuels. The remaining chapters deal with calorific values of solid and liquid fuels, technical pyrometry, and combustion calculations.

The chapter on the testing of liquid fuels is designed to meet the needs of the fuel chemist who may be called upon from time to time to examine fuel oils and allied materials with a view to ascertaining their compliance with specifications. Standard tests for specific gravity, viscosity, flash point, sediment, water content, carbon residue, asphalt, pour point, ash, calorific value, and sulphur content are described.

In the chapter on "Gas Analysis" the description of the Improved Hempel Apparatus might well have been omitted. The analysis of hydrocarbon gases by fractionation by liquid air in the Burrel, Seibert, and Robertson equipment which is included has been out-of-date for nearly twenty years. This is the only fractionation method described, and no mention of the modern Podbielniak apparatus is included.

The book appears to be designed primarily for students taking a course in fuel technology, and will be of little value to either the expert fuel or oil technologist.

T. G. HUNTER.

BOOKS RECEIVED.

Consideracoes sobre as Propriedades Anti-Detonantes do Alcool e seu Emprego como Combustivel. By Fernando Alfonso Baster Pilar, Armando Silva de Araujo. Instituo Nacional de Tecnologia. Rio de Janeiro.

Transactions of the Geological Society of Glasgow. Volume XX, Part II, 1938–1942.

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INSTITUTE NOTES.

DECEMBER, 1942.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute or transfer to another grade of membership. In accordance with the By-laws the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parenthesis.

FLEMING, Peter, Research Chemist. (*Dr. A. E. Dunstan.*) (Application for transfer from Member to Fellow.)

FLETCHER, Robert Mason, Engineer, Duke & Ockenden, Ltd. (*A. Beeby Thompson ; Maurice A. Ockenden.*) (Application for transfer from Member to Fellow.)

OCKENDEN, Maurice A., Engineer, Duke & Ockenden, Ltd. (*A. Beeby Thompson ; R. M. Fletcher.*) (Application for transfer from Member to Fellow.)

CHAPMAN, George Norman, Research Chemist, Alexander Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

CHRISTIAN, John Bell, Assistant Manager, Trinidad Leaseholds, Ltd. (*B. G. Banks ; E. J. M. Tait.*)

JAMIESON, John, Research Chemist, Alexander Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

PATMAN, Frederick John, Analytical Chemist, Ministry of Supply. (*A. R. Stark ; E. P. Driscoll.*)

PEPPER, Albert Cecil, Research Chemist, Alexander Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

RICHARDS, Alan Roy, Research Chemist, Trinidad Leaseholds, Ltd. (*F. Morton ; Arthur G. V. Berry.*)

ROY, Clarke, Works Manager. (*S. Elliman ; L. Mills.*)

WIGZELL, Albert Orsborn, Works Chemist, A. Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

Students.

BADDELEY, Alan Rowland Walsworth
FAULKNER, Brian Alex.
MARTYN, John Robert
} All proposed by *Prof. F. H. Garner.*

SHELDON, James Hervey
SUGDEN, Walter
} Proposed by *Prof. V. C. Illing.*

NEWS OF MEMBERS.

Information has been received that Mr. W. M. Wright, who was reported in the October *Journal* to be missing, believed killed, is alive and well. He was one of the party who, under the leadership of Admiral Chang Chak, escaped into Free China when Hong Kong fell, and was awarded the D.S.C. for his part in the escape. He subsequently served for a time in Rangoon, and is now in Calcutta.

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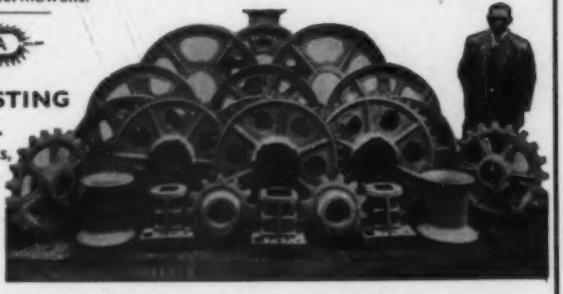

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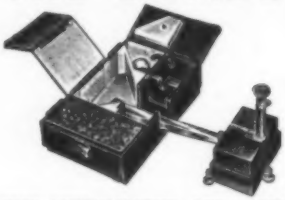

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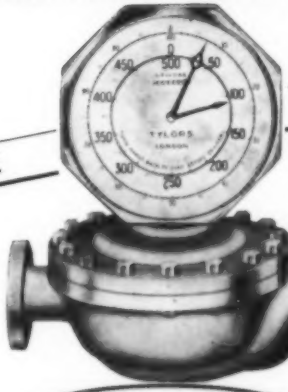

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INSTITUTE NOTES.

FEBRUARY, 1942.

FORTHCOMING MEETINGS

Friday, 1st May. **Annual General Meeting** at 12 noon.

Institute Luncheon at 1.15 p.m. at the Connaught Rooms, London, W.C. 2.

The Council is making arrangements for a series of monthly meetings of the Institute to be held in London during May to September.

NOMINATION AS PRESIDENT.

Mr. CHRISTOPHER DALLEY, M.I.E.E., Vice-President, has been nominated by the Council as President of the Institute for the year 1942–43.

HONOURS.

H.M. The King has conferred the award of the Knight Grand Cross of the Order of the Bath upon Sir FRANK E. SMITH (Fellow) for his distinguished services to aircraft production and supply.

NEW MEMBERS.

The following elections have been made by the Council in accordance with the By-Laws, Sect. IV, para. 7.

Elections are subject to confirmation in accordance with the By-Laws, Sect. IV, paras. 9 and 10.

As Students.

ASHFORTH, George Kenneth.
BOESE, Alan Charles.
CLAYTON, Peter Brierley.
DOD, Geoffrey Francis.
DRYER, Stanley Raymond Collins.
FOSTER, Douglas Vernon.
GARRETT, Philip Arthur.
HICKS, Alexander Edward.
LINDNER, James Neville Donovan.
WALL, Thomas Gulliver.
WINWARD, Anthony.

All the above are students at the Department of Oil Engineering and Refining, The University of Birmingham.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute or transfer to another grade of membership.

The names of the candidate's proposer and seconder are given in parentheses.

BURROUGHS, Leland Clare, B.Sc., Technologist, Shell Oil Co., New York (*R. I. Lewis ; Dr. R. Stern.*)

HALL, Reginald Harold, B.Sc., Chemist, Petroleum Board. (*C. E. Burnett ; J. E. Haslam.*)

HOBBS, John Francis, B.Sc., Engineer, Anglo-Iranian Oil Co. (*D. Comins ; C. A. P. Southwell.*)

JOHNSON, Joseph James, Draughtsman, Petroleum Board. (*J. A. Oriel ; C. G. Williams.*)

JONES, Edward Lewis, Lt. R.C.E., B.Eng., Chemical Engineer, Calgary, Canada.

OLDFIELD, Arthur Edward, Police Officer, Birmingham, (*T. G. Hunter ; J. F. F. McQueen.*)

PATERSON, Leonard Andrew, Director, Morris & Co., Shrewsbury. (*C. E. Burnett.*)

PROCTOR, Wilfred Ernest, Lubricating Oil Supervisor, Petroleum Board (*R. G. Stickland ; A. Moon.*)

SCOTT, Roland, A.M.Inst.Chem.E., Chemical Engineer, Midland Tar Distillers Ltd., Oldbury. (*T. G. Hunter ; A. W. Nash.*)

SMITH, William Henry, Lubricating Oil Representative, United Oil Co., Stoke-on-Trent.

STRAWSON, John William, Engineering Draughtsman, Petroleum Board. (*J. A. Oriel ; C. G. Williams.*)

TIPLER, Francis, M.Inst.Mech.E., Engineer, Petroleum Board. (*C. Chilvers ; E. B. Evans.*)

WESTON, Reginald Alfred, Chemist, Cargo Superintendents (London), Ltd. (*H. Moore.*)

WHYTE, Thomas Robert Norman, Superintendent, Petroleum Board.

WILSON, John Wilfred, B.Sc., Ph.D., Research Chemist, I.C.I., Ltd. (*R. F. Goldstein ; C. E. Wood.*)

WITARD, Stuart Lancaster, Mechanical Engineer, Le Grand, Sutcliff & Gell, Ltd. (*J. Cuthill, N. Matheson.*)

Applications for Transfer.

FISCHER, Raoul Konrad (Member). (*G. H. Coxon ; C. W. Wood.*)

LAND, Edwin Jacob (Associate Member). (*B. S. Brailey ; R. A. Eldridge.*)

MATHESON, Niels (Member). (*C. Dalley ; R. R. Tweed.*)

ARTHUR W. EASTLAKE,
Honorary Secretary.

INSTITUTE NOTES.

MARCH, 1942.

DEATH OF PROFESSOR A. W. NASH.

It is with deep regret that we have to record the death of Professor A. W. Nash, President of the Institute, on Saturday, 14th March, at the age of fifty-five.

Professor Nash had been ill since the autumn of 1941, and in November last he underwent a serious operation.

The Council tenders its sincere sympathy to Mrs. Nash and the members of the family in their bereavement.

JOINT HONORARY SECRETARY.

The Council has appointed Mr. ASHLEY CARTER, A.M.I.Mech.E., F.Inst.Pet., to be Joint Honorary Secretary of the Institute with Mr. Arthur W. Eastlake.

VICE-PRESIDENTS.

The Council has elected the following to be Vice-Presidents of the Institute for the Session 1942–43 :

Mr. ASHLEY CARTER.	Mr. A. C. HARTLEY.
Mr. G. H. COXON.	Prof. V. C. ILLING.
Dr. F. H. GARNER.	Dr. F. B. THOLE.

RETIRING MEMBERS OF COUNCIL.

The following members of Council retire at the Annual General Meeting, 1942, and offer themselves for re-election : Dr. E. B. EVANS, Mr. J. S. JACKSON, Mr. H. C. TETT, and Dr. A. WADE.

NEW MEMBERS.

The following elections and transfers have been made by the Council in accordance with the By-laws, Sect. IV, para. 7.

Elections are subject to confirmation in accordance with the By-laws, Sect. IV, paras. 9 and 10.

As Fellows.

BURROUGHS, Leland Clare	U.S.A.
TIPLER, Francis	England.

Transfer to Fellows.

FISCHER, Raoul Konrad	England.
MATHESON, Niels	"

As Members.

PATERSON, Leonard Andrew	England.
SCOTT, Roland	,,
WILSON, Wilfrid John	,,

Transfer to Member.

LAND, Edwin Jacob	England.

As Associate Members.

HALL, Reginald Harold	England.
HOBBS, John Francis	,,
JOHNSON, Joseph James	,,
OLDFIELD, Arthur Edward	,,
PROCTOR, Wilfred Ernest	,,
STRAWSON, John William	,,
WESTON, Reginald Alfred	,,

Transfer to Associate Member.

LORNE, Henry Thomas	Scotland.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute or transfer to another grade of membership, and in accordance with the By-laws the proposals will not be considered until the lapse of at least one month subsequent to the issue of this *Journal*, during which any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of any candidate.

The object of this information is to assist the Council in grading candidates according to the class of membership.

The names of the candidate's proposer and seconder are given in parentheses.

HECKMAN, Maxwell, Cracking Plant Foreman, Bahrein Petroleum Co., Bahrein.

HOLLINGSWORTH, Clifford, F.I.C., Experimental Officer, Ministry of Supply. (*J. S. Jackson ; D. L. Samuel.*)

WITARD, S. L., Production Manager, Messrs. Le Grand, Sutcliff & Gell, Ltd. (*J. Cuthill ; N. Matheson.*)

ARTHUR W. EASTLAKE,
ASHLEY CARTER,
Joint Honorary Secretaries.

INSTITUTE NOTES.

MAY, 1942.

MEMBERS SERVING WITH H.M. FORCES.

The Institute has received notification of the following changes or additions to lists already published :—

Balfour, N. R., to be Captain, R.A.O.C.
Barrett, G. M., Capt., R.A.
Brunner, D. G., 2nd-Lieut., R.A.O.C.
Bushnell, G. H. S., Lieut., R.E.
Cole, F. A. J., Capt., Indian Army.
Haker, J., Ft.-Lieut., R.A.F., V.R.
Manderstam, L. H., Capt.
Moore, J. L., R.A., now Lieut.
Neilson, I. McI., R.E.
Paul, D. S., R.A.S.C., now Lieut.-Col.
Perks, J. G., 2nd-Lieut., R.A.O.C.
Perrott, T. P., Capt., R.E.
Simpson, A. M., R.A.F.
Whitehead, R. C., Royal Fusiliers.
Willmott, I. A., P.-O., R.A.F., V.R.

NEW MEMBERS.

The following elections have been made by the Council in accordance with the By-Laws, Sect. IV, para. 7.

Elections are subject to confirmation in accordance with the By-Laws, Sect. IV, paras. 9 and 10.

As Fellow.

THACKER, Gilbert Doe ... ... England.

Transferred to Fellow.

STALLARD, Richard Joseph ... ... England.

As Members.

CLARK, Henry William ... ... England.
FEATHERSTONE, Arthur James ... ... ,,
HEALEY, Harry ... ... ,,
HOLLINGSWORTH, Clifford ... ... ,,
POSTLETHWAITE, Cyril ... ... ,,
WILSON, Alexander ... ... ,,
WITARD, Stuart Lancaster ... ... ,,

Transferred to Member.

SNOW, Percy Henry ... ... England.

As Associate Members.

CHATTERLEY, Leslie George ... ... England.
PATERSON, Edward Victor ... ... ,,
SMITH, William Henry ... ... ,,
WHYTE, Thomas Robert Norman ... ... ,,

Transferred to Associate Members.

GREEN, Sydney James	England.
KEELING, Philip Stanley	Burma.
YOUNG, Raymond Owen	Trinidad.

JOURNALS FOR OVERSEAS MEMBERS.

Numerous requests are being received by the Secretary for copies of back issues of the *Journal* which have failed to reach their destination overseas. The Council has agreed that copies of the *Journal* to replace those lost in transit shall be issued to overseas members free of charge. But it is requested that members will not apply for such *Journals* until at least six months after the date they would have normally have been received. Preferably, a list of missing numbers should be retained until after the war, when they will be supplied in bulk. The Institute has at present ample stocks of the *Journal* covering the past three years, sufficient to meet all likely demands.

JOURNAL, AUGUST AND SEPTEMBER 1941.

The *Journal* was not published in August nor September 1941.

The issue following July 1941 (No. 213) was that of October 1941 (No. 214).

The *Annual Reviews of Petroleum Technology*, Vol. 6, was issued to all members and subscribers entitled to receive the monthly *Journal* in lieu of the issues of August and September 1941. It was despatched in the same wrapper as the October 1941 *Journal*.

CHANGE OF THE INSTITUTE'S ADDRESS.

As from Monday, 15th June, 1942, the offices of the Institute will be transferred from the University of Birmingham to the Imperial College of Science and Technology, London, S.W.7.

All communications should be addressed to :

The Secretary,
The Institute of Petroleum,
c/o The Imperial College of Science and Technology,
Prince Consort Road,
LONDON, S.W.7.

ARTHUR W. EASTLAKE,
ASHLEY CARTER,
Joint Honorary Secretaries.

APPOINTMENT OF SECRETARIAL ASSISTANT.

The Council invites applications from members of the Institute and others for an appointment as Secretarial Assistant on the Institute's staff in London. Secretarial and accounting experience essential. Applications, stating salary required, should be forwarded to the Secretary not later than 30th June, 1942.

INSTITUTE NOTES.

JUNE, 1942.

CHANGE OF THE INSTITUTE'S ADDRESS.

The offices of the Institute have been transferred from the University of Birmingham to the Imperial College of Science and Technology, London, S.W.7.

All communications should be addressed to:

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LONDON, S.W.7.

Telephone: Kensington 9572.

BACK ISSUES OF JOURNAL.

In view of the scarcity of many back issues of the *Journal*, the Council feels that it would be advantageous to have on record details of complete sets from 1914 onwards.

It would be helpful, therefore, if members possessing such sets would send particulars to the Secretary, for private record purposes only.

Similarly, it would be appreciated if members who are considering the disposal of back volumes or separate parts of the *Journal*, either for sale or salvage, would first send details to the Secretary.

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INSTITUTE NOTES.

JULY, 1942.

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HONOURS.

FREDERICK GODBER, ESQ. (Fellow), was created a Knight Bachelor in the Birthday Honours List of June 11th, 1942. Sir Frederick Godber is Chairman of the Overseas Supply Committee of the Petroleum Board.

PERSONAL

Dr. F. H. GARNER (Vice-President), has been appointed Professor of Petroleum Technology of the University of Birmingham, in succession to the late Prof. A. W. Nash.

Mr. JAMES KEWLEY (Past-President) has been awarded the Silver Medal of the Royal Society of Arts for his recent paper on "The Evolution in the Petroleum Industry."

Dr. A. E. DUNSTAN (Past President) is President of the British Association of Chemists.

Dr. G. EGLOFF is President of the American Institute of Chemists.

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INSTITUTE NOTES.

AUGUST, 1942.

STAFF.

During the month of July, Mr. S. J. Astbury tendered his resignation from the position of secretary. This was accepted. Mr. F. H. Coe was appointed Acting Secretary of the Institute, taking up duties on 1st August, 1942.

HONOURS.

The King has approved the award to Major Percy R. Clark, R.A.O.C., of the Greek Distinguished Service Medal, conferred upon him by the King of Greece.

FORTHCOMING MEETINGS.

An interesting and widely comprehensive series of meetings is being arranged of which due notice will be given. It is hoped the first will take place in September, and monthly thereafter.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute or transfer to another grade of membership, and in accordance with the By-laws the proposals will not be considered until the lapse of at least one month subsequent to the issue of this *Journal*, during which any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of any candidate.

The object of this information is to assist the Council in grading candidates according to the class of membership.

The names of the candidate's proposer and seconder are given in parentheses.

BATTYE, Arthur, Chairman, Messrs. D. Battye & Son, Ltd. (*N. L. Skilling ; E. E. Manning.*)

BISHOP, Henry John, Petroleum Inspector, Messrs. B. & R. Redwood. (*W. F. Jelffs ; A. T. White.*)

CRAGG, John Coles, Chemist, Messrs. C. C. Wakefield & Co., Ltd. (*E. A. Evans ; S. J. M. Auld.*)

GOTTESMANN, Manfred, Technical Salesman, Socony-Vacuum Oil Co. (*Transfer to Associate Member.*)

MITCHELL, John, Chemist, Attock Oil Co., Ltd. (*T. T. McCreath ; J. G. Annan.*)

POCOCK, Neville Richard, Assistant Oil Stocks Superintendent, Trinidad Leaseholds, Ltd. (*J. H. McLea ; B. G. Banks.*)
RIDLER, Kenneth Edgar William, Engineer, R.A.F., Farnborough. (*Dr. F. H. Garner ; H. C. Tett.*)
WILDING, John Sherley, Chemist, R.A.S.C. (*R. J. Bressey ; J. S. Jackson.*)

PUBLICATION OF STANDARD METHODS.

Work in connection with "Standard Methods for testing Petroleum and its Products" is in the hands of the printers and is expected to be published about the beginning of November next.

ARTHUR W. EASTLAKE,
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Joint Honorary Secretaries.

Kindly mention this Journal when communicating with Advertisers.

INSTITUTE NOTES.

SEPTEMBER, 1942.

FORTHCOMING MEETINGS.

The next meeting will take place on October 20th at the Junior Institute of Engineers.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute and in accordance with the By-laws the proposals will not be considered until the lapse of at least one month subsequent to the issue of this *Journal*, during which any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of any candidate.

The object of this information is to assist the Council in grading candidates according to the class of membership.

The names of the candidate's proposer and seconder are given in parentheses.

ANDERSON, Ronald Turnbull, Asst. Works Chemist, The Shell Company of Australia. (*T. Hartigan ; H. W. Stevenson.*)

CURRAN, Bernard Reginald, Manager, Industrial Traders, Ltd. (*Harold Moore ; H. E. Charlton.*)

HURRELL, William Mark, Manager, Installations Branch, Distribution Department, Anglo-Iranian Oil Co., Ltd. (*Dr. A. E. Dunstan ; G. H. Coxon.*)

MACNEILL, Ian Victor Noble, Assistant Operating Superintendent, Magnesium Metal Corporation. (*J. E. Hackwood.*)

SCHNABEL, Dr. Fred, Chemical Engineer. (*L. Ivanovszky ; V. Biske.*)

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ASHLEY CARTER,
Joint Honorary Secretaries.

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FOR TESTING

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1942

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Other new methods include aniline points of products which develop high pressures at the analine point ; diesel fuel diluent in crankcase oils ; and a rapid method of determining sulphur by combustion in a quartz tube.

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INSTITUTE NOTES.

OCTOBER, 1942.

PROFESSOR F. H. GARNER.

The Institute wish to congratulate Professor Garner on his appointment to the Chair of Oil Engineering and Refining at the University of Birmingham. The Chair was founded by the late Lord Cadman, and was held by Professor Nash until his death in March.

Professor Garner was in charge of the lubricating oil laboratory at the Royal Aircraft Establishment in 1917, and since then he has been continuously engaged in work connected with the petroleum industry. He was an 1851 Scholar of the University of Birmingham in 1919, and became a Fellow of the Mellon Institute of Industrial Research at Pittsburgh in the Petroleum Fellowship in 1920. In 1921 he took the Ph.D. of the University of Pittsburgh, with which the Mellon Institute is associated. He returned from the United States in the same year and became Chief Chemist of the Agwi Petroleum Corporation, whose refinery at Fawley was then being constructed, and in 1928 became Chief Chemist of the Anglo-American Oil Co., Ltd. In 1935 he took charge of the Esso European Laboratories, comprising both Engine and Chemical Sections, and he has now relinquished this post to take up the Chair at Birmingham.

Professor Garner has been associated with the Institute of Petroleum since 1921, when he joined as an Associate Member, transferring to Membership in 1925. In 1936 he was elected Vice-President and in the following year he became Honorary Associate Editor of the *Journal*. He was elected a Fellow in 1939. He has published a number of papers on petroleum subjects, including papers on the knock-rating of pure hydrocarbons and on viscosity, and is the editor of the *Annual Reviews of Petroleum Technology* which are published by the Institute. He is also Chairman of the Standardization Committee which will shortly publish the 4th Edition of "Standard Methods of Testing Petroleum and its Products."

Professor Garner is also Vice-Chairman of the Road and Building Materials Group of the Society of Chemical Industry, and editor of a book on "Modern Road Emulsions" whose 2nd Edition was published in 1939.

CANDIDATES FOR ADMISSION.

The following has applied for admission to the Institute, and in accordance with the By-laws the proposal will not be considered until the lapse of at least one month subsequent to the issue of this *Journal*, during which time any Fellow, Member or Associate Member may communicate by letter to the Secretary, for the con-

fidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of the candidate's proposer and seconder are given in parenthesis.

HARKESS, John Mackay, Chemist, Lobitos Oilfields, Ltd. (*J. S. Parker; V. Biske.*)

STUDENTS' SECTION, BIRMINGHAM UNIVERSITY.

At a general meeting of the Students' Section of the Institute on 29th September, the following officers were elected :—

Chairman	A. W. Pearce.
Vice-Chairman	P. A. Garrett.
Secretary	G. F. Dod.
Hon. Sec. and Treas.	Dr. A. H. Nissan.
Committee Members	M. L. Fellowes.
	G. K. Ashforth.

NEWS OF MEMBERS.

The Institute has received information that Mr. T. H. G. Brayfield (Fellow), and Mr. A. W. Black (Fellow) are in an internment camp in Hong Kong and are both in good health.

Mr. W. M. Wright (Member) is reported to be missing, believed killed in action.

MEMBERS SERVING WITH HIS MAJESTY'S FORCES.

The Council invites members serving with any branch of H.M. Forces to send a note of their rank and unit to the Secretary.

The following additions to lists already published have been received :—

DIXON, J. F., Pilot Officer, R.A.F.V.R. (Technical Branch).
WYGARD, E. J., Private, Polish Corps of Signals.
WISEMAN, K. W., 2nd Lieut., R.A.O.C. (Radio Location Maintenance).

ADDRESSES OF MEMBERS.

Since the outbreak of war the postal addresses of many members have changed. A considerable number of such changes has been notified to the Secretary, and every effort has been made to give effect to these in the despatch of the *Journal*. Members whose *Journals* are still being forwarded to a wrong address are asked to advise the Secretary of their correct address.

INSTITUTE NOTES.

NOVEMBER 1942.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute. In accordance with the By-laws, the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parentheses.

BOWES, Emmerson, Laboratory Assistant, Lobitos Oilfields, Ltd. (*V. Biske*; *J. Wood-Mallock.*)

BUTCHER, Kenneth Leopold, Chemical Engineer, Shell Refining & Marketing Co. (*John A. Oriel*; *G. W. Dorrell.*)

HUMPHREY, Kenneth Ernest, Chemical Engineer, Foster Wheeler, Ltd. (*Dr. R. C. Fisher*; *E. A. Satchell.*)

KING, Stanley, Research and Refinery Plant Control Chemist, London and Thames Haven Oil Wharves, Ltd. (*E. Hunting*; *W. J. Wright.*)

MCEWEN, George Charles, Chemist, A.I.D. Test House. (*E. R. Styles*; *F. W. Bristow.*)

NEWBALD, Walter Noel Selby, Labour Officer, Petroleum Board. (*E. W. Unmack*; *E. J. Dunstan.*)

SIMPKIN, Francis Ronald, General Manager, Eastern Counties Lubricants, Ltd. (*Frank Dakin*; *Walter Kay.*)

MEMBERS SERVING WITH HIS MAJESTY'S FORCES.

The Council invites members serving with any branch of H.M. Forces to send a note of their rank and unit to the Secretary.

The following addition to lists already published has been received :—

HURST, N., Acting Pilot Officer, R.A.F.

ADDRESSES OF MEMBERS.

Since the outbreak of war the postal addresses of many members have changed. A considerable number of such changes has been notified to the Secretary, and every effort has been made to give effect to these in the despatch of the *Journal*. Members whose *Journals* are still being forwarded to the wrong address are asked to advise the Secretary of their correct address.

CONTRIBUTIONS TO THE *JOURNAL*.

There is at present a great shortage of contributions to the *Journal*. Members are invited to submit papers on any subject relating to Petroleum Technology, for consideration by the Publications Committee. Such contributions should be typed on one side of the paper only, and the number of diagrams and tables kept down to the minimum.

INSTITUTE NOTES.

DECEMBER, 1942.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute or transfer to another grade of membership. In accordance with the By-laws the proposals will not be considered until the lapse of at least one month after the publication of this *Journal*, during which time any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of the candidate.

The object of this information is to assist the Council in grading the candidate according to the class of membership.

The names of candidates' proposers and seconders are given in parenthesis.

FLEMING, Peter, Research Chemist. (*Dr. A. E. Dunstan.*) (Application for transfer from Member to Fellow.)

FLETCHER, Robert Mason, Engineer, Duke & Ockenden, Ltd. (*A. Beeby Thompson ; Maurice A. Ockenden.*) (Application for transfer from Member to Fellow.)

OCKENDEN, Maurice A., Engineer, Duke & Ockenden, Ltd. (*A. Beeby Thompson ; R. M. Fletcher.*) (Application for transfer from Member to Fellow.)

CHAPMAN, George Norman, Research Chemist, Alexander Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

CHRISTIAN, John Bell, Assistant Manager, Trinidad Leaseholds, Ltd. (*B. G. Banks ; E. J. M. Tait.*)

JAMIESON, John, Research Chemist, Alexander Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

PATMAN, Frederick John, Analytical Chemist, Ministry of Supply. (*A. R. Stark ; E. P. Driscoll.*)

PEPPER, Albert Cecil, Research Chemist, Alexander Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

RICHARDS, Alan Roy, Research Chemist, Trinidad Leaseholds, Ltd. (*F. Morton ; Arthur G. V. Berry.*)

ROY, Clarke, Works Manager. (*S. Elliman ; L. Mills.*)

WIGZELL, Albert Orsborn, Works Chemist, A. Duckham & Co., Ltd. (*Prof. J. S. S. Brame ; Alexander Duckham.*)

Students.

BADDELEY, Alan Rowland Walsworth
FAULKNER, Brian Alex.
MARTYN, John Robert
} All proposed by *Prof. F. H. Garner.*

SHELDON, James Hervey
SUGDEN, Walter
} Proposed by *Prof. V. C. Illing.*

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NEWS OF MEMBERS.

Information has been received that Mr. W. M. Wright, who was reported in the October *Journal* to be missing, believed killed, is alive and well. He was one of the party who, under the leadership of Admiral Chang Chak, escaped into Free China when Hong Kong fell, and was awarded the D.S.C. for his part in the escape. He subsequently served for a time in Rangoon, and is now in Calcutta.

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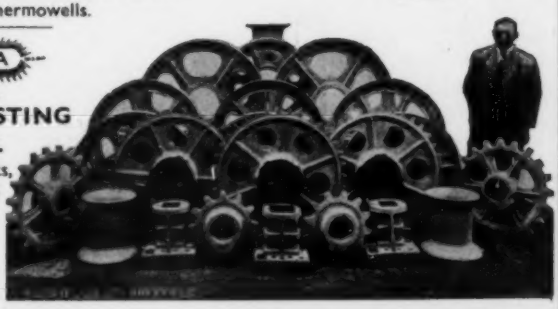

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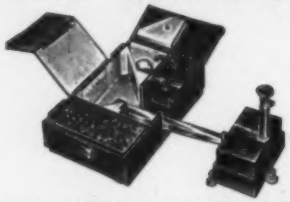

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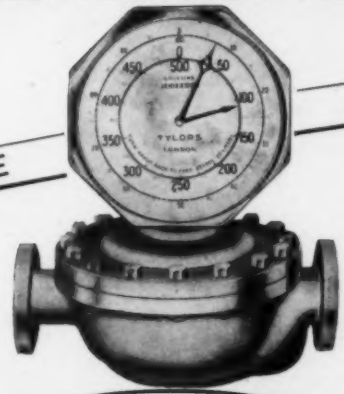

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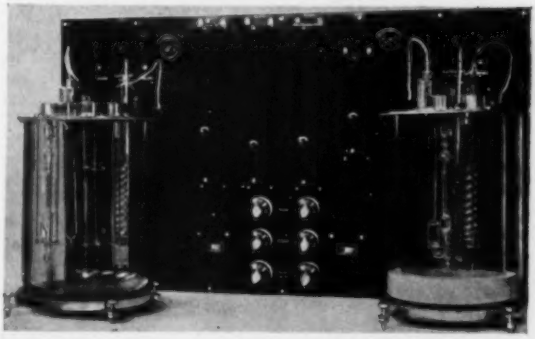

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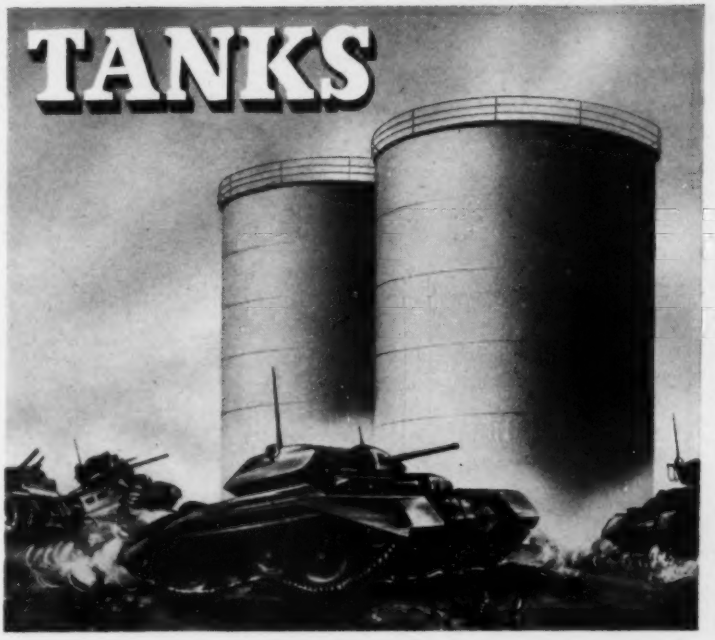

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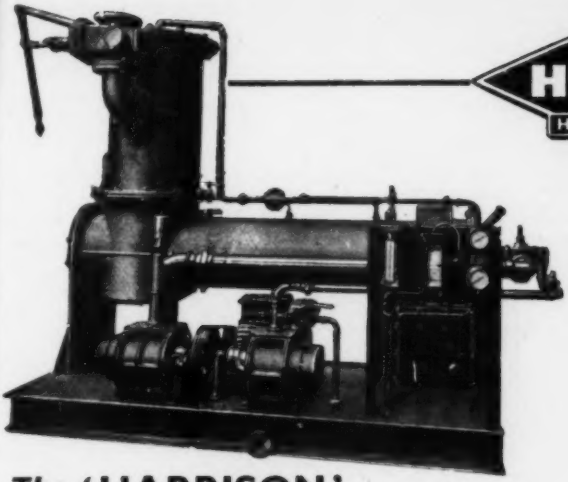

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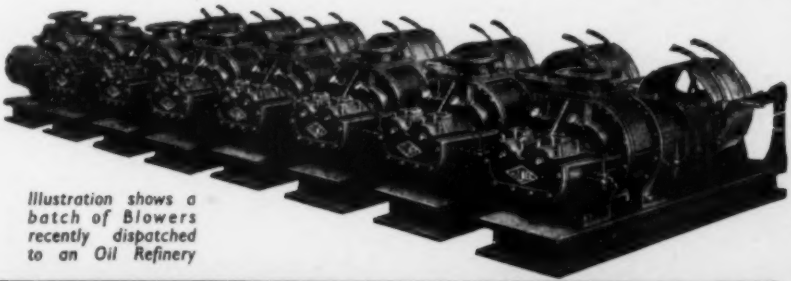

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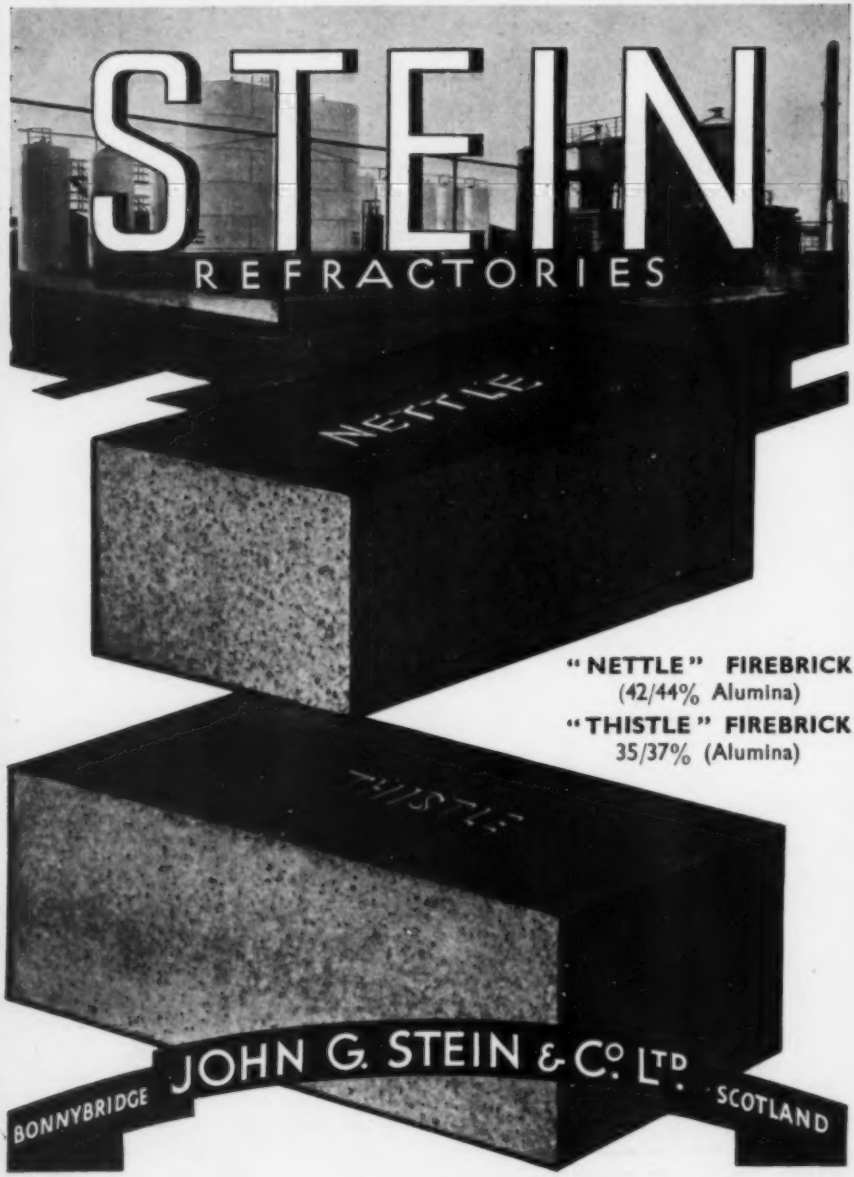

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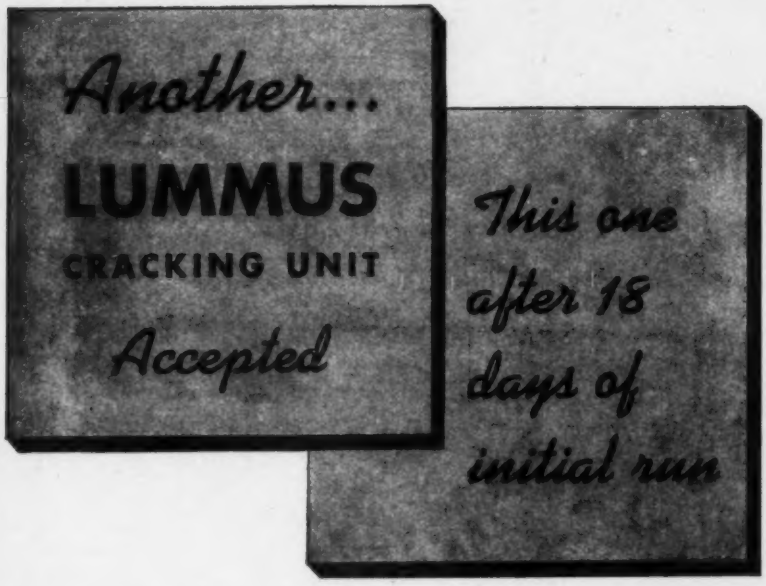

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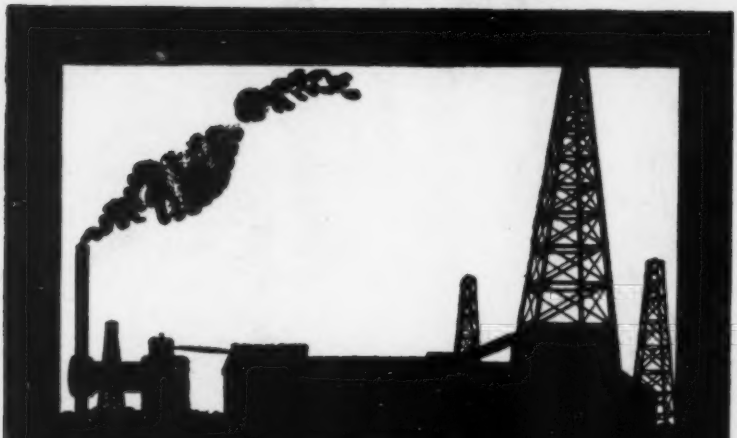

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